MONROE ELECTRONICS, INC. 100 Housel Ave. Lyndonville, N. Y. 14098

MANUFACTURERS OF ELECTRONIC INSTRUMENTS AND SYSTEMS

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– RETURN TO –
INSTRUMENT CONTROL
SYLVANIA SES -- West

INSTRUCTION MANUAL

FOR

ISOPROBE® ELECTROSTATIC VOLTMETER
MODEL 144 S-4 S/N 720

DETECTOR/PREMAPLIFIER PROBE
MODEL 1009C S/N 1167

MODULE	S/N
368B-15	2137, 2138
369B-15	1166
3011	1027
3010	1002
370A-1	955
353B-4 D	2105
373A-2	932
353B-4BSP	2195
371A	1078
405	1047

Designed and Manufactured
by
MONROE ELECTRONICS, INC.
Middleport, New York
14105

Rev. 10/71/144

WARRANTY

Monroe Electronics, Inc. warrants each instrument and sub-assembly manufactured by them to be free from defects in material and workmanship for a period of one year after delivery to the original purchaser.

Liability under this warranty is limited to servicing, adjusting or replacement of defective parts (other than tubes, fuses or batteries) on any instrument returned to the factory for this purpose, transportation charges prepaid.

This warranty does not apply to products subjected to unauthorized repair or modification.

Before returning an instrument to the factory for any reason, notify us of the difficulty encountered; also the model and serial number of the instrument. We will furnish you with service and shipping instructions.

MONROE ELECTRONICS, INC.
5 Vernon Street
Middleport, New York 14105

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Section 1

SPECIFICATIONS

A. Applications:

This instrument permits accurate measurement of the DC potential of a small area on an electrostatically charged surface without physical contact. Its unique electrostatic chopping renders drift negligible. Its very high gain 100% degenerative feedback renders its output insensitive to probe-to-surface spacing.

B. Features:

-- All Silicon Solid State Circuitry
-- Superior Accuracy
Stability
Reliability
Ease of Maintenance
-- Low Noise
-- Fast Speed-of-Response

C. Range:

0 to ±2000 volts DC.

D. Static Accuracy:*

The fedback probe potential follows the unknown input of an equipotential surface to an accuracy significantly better than 0.1% at 1/8 inch probe-to-surface spacing.

E. Speed-of-Response:

Less than 7.5 milliseconds from 10% to 90% for critically damped response to 2000 volts input step at 1/8 inch probe-to-surface spacing.

F. Drift:*

1. Less than 100mV per hour, non-cumulative, in uncontaminated atmosphere.

2. Typically better than ±15 millivolts stability for a line voltage of 117 volts ±10%.

3. The effects of 10°C temperature variations or changes between 10 and 90% in relative humidity are indiscernible.

G. Noise: *for 5mil spacing, normal lab environment

This instrument has extremely high open loop gain (approximately 10^9) with the result that the limiting factor in its performance is noise associated with its input circuit.

1. Wide band output is less than 50mV RMS referenced to the input.

2. Meter indicated noise is less than 15mV peak-to-peak.

H. Surface Resolution:

See attached plot (Figure 1) of indicated voltage relative to a step potential discontinuity for various probe-to-surface spacings.

I. Probe-to-Surface Spacing Error:

At one inch probe-to-surface spacing, a typical test reveals the probe will follow a large equipotential surface potential to approximately 1.0% accuracy although a significant deterioration in noise, drift, and speed-of-response will result. See the attached plot of % Error vs Spacing. (Figure 2)

J. Meter Ranges:

±1, 2, 5, 10, 20, 50, 100, 200, 500, 1000 and 2000 volts full scale ranges are provided.

K. Meter Accuracy:

Three metering options are provided whose accuracies are tabulated below:

Option	Indicator	Multiplier Accuracy	Full Scale Meter Accuracy
-1	2% Center Zero Meter	1%	5%
-2	2% L. H. Zero Meter	1%	3%
-4	0.5% L. H. Zero Meter	0.1%	0.75%

We have from one

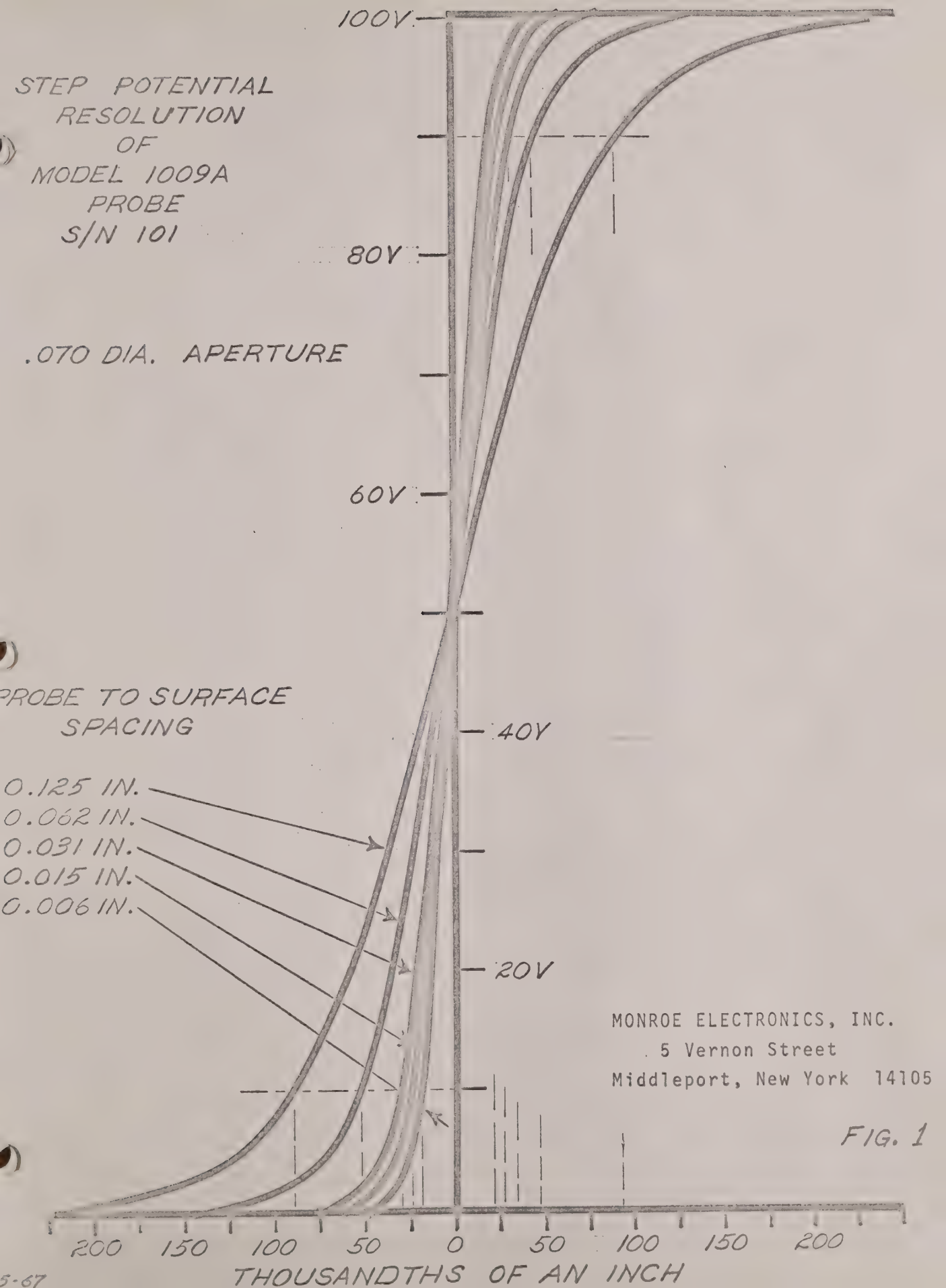

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FIG. 1

5-67

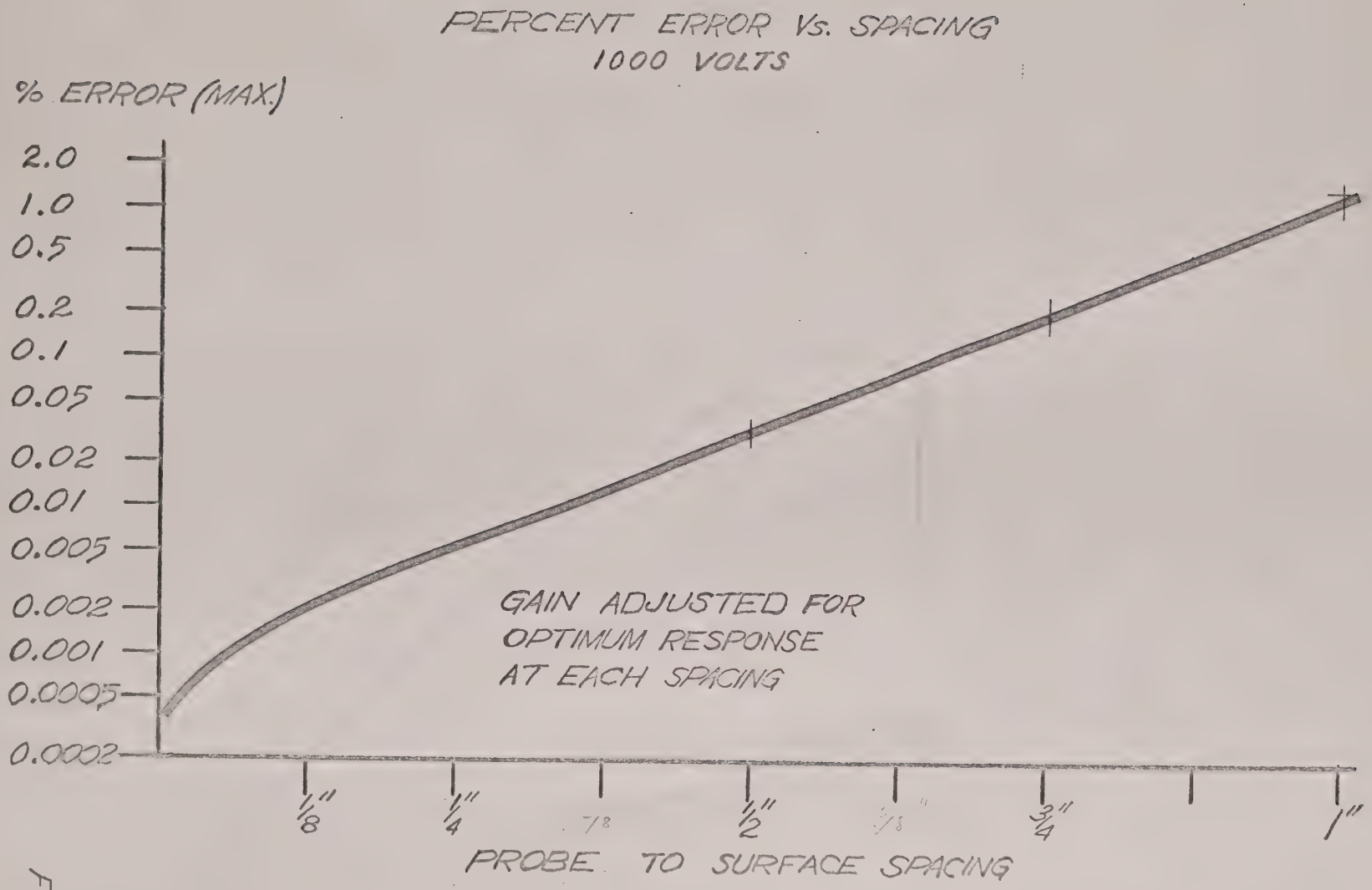
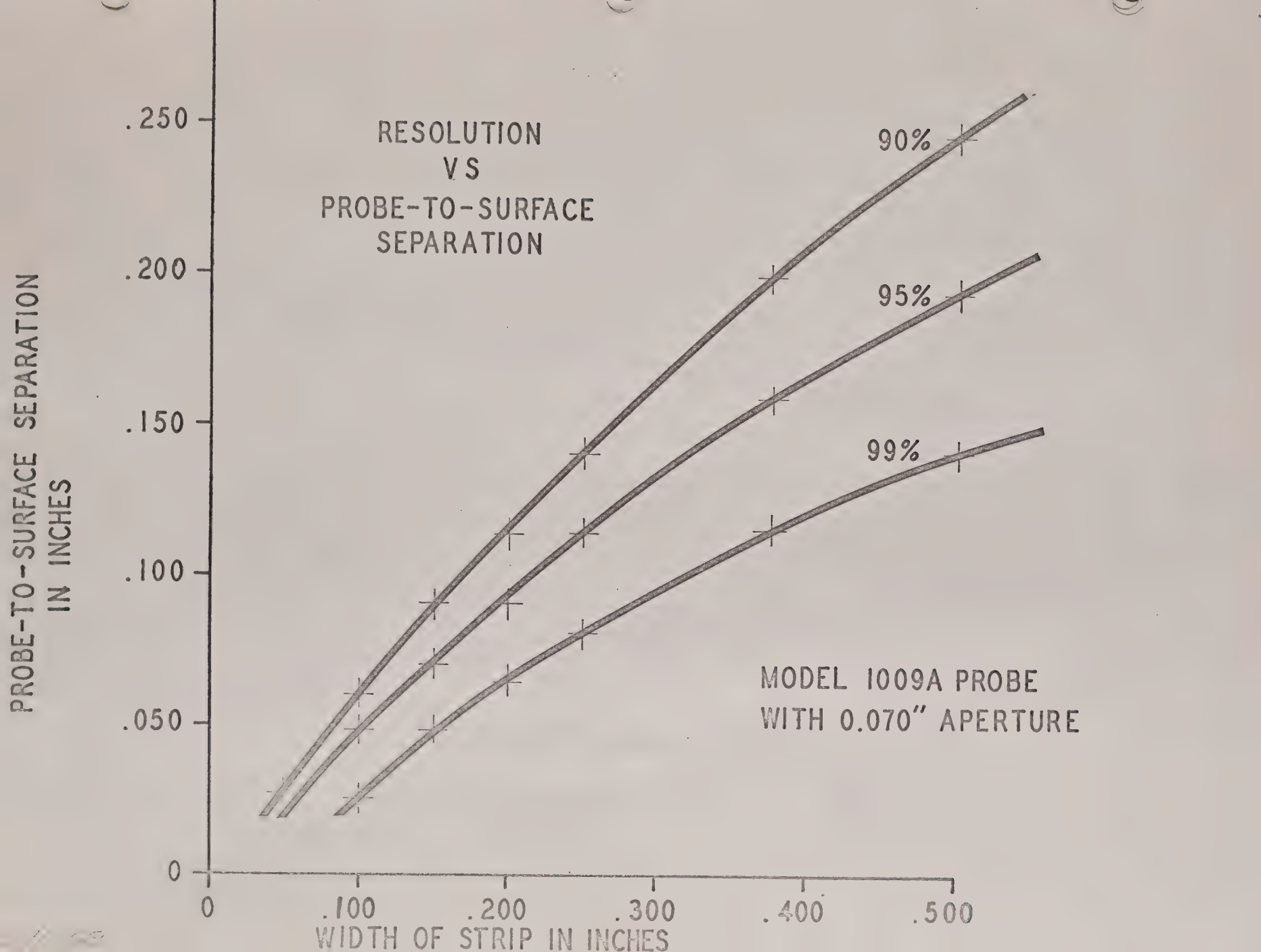
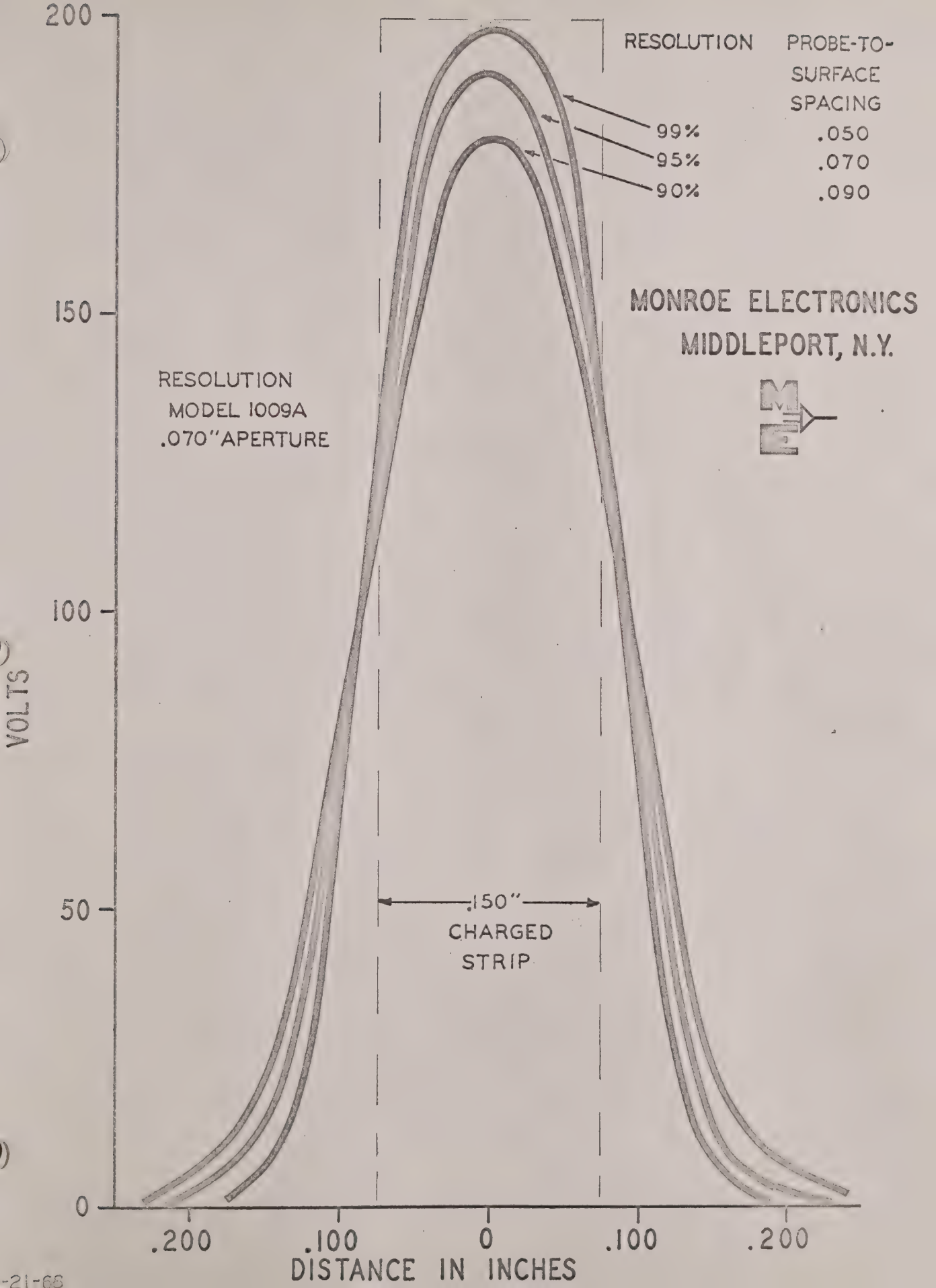

PERCENT ERROR Vs. SPACING
1000 VOLTS
% ERROR (MAX.)
2.0
1.0
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
GAIN ADJUSTED FOR
OPTIMUM RESPONSE
AT EACH SPACING
1/8"
1/4"
1/2"
3/4"
1"
PROBE TO SURFACE SPACING

FIG. 2


RESOLUTION
VS
PROBE-TO-SURFACE
SEPARATION
90%
95%
99%
MODEL 1009A PROBE
WITH 0.070" APERTURE
PROBE-TO-SURFACE SEPARATION
IN INCHES
.250
.200
.150
.100
.050
0
0
.100
.200
.300
.400
.500
WIDTH OF STRIP IN INCHES


200
150
100
50
0
VOLTS
RESOLUTION
PROBE-TO-SURFACE SPACING
99%
95%
90%
.050
.070
.090
MONROE ELECTRONICS
MIDDLEPORT, N.Y.
RESOLUTION
MODEL 1009A
.070" APERTURE
.150"
CHARGED
STRIP
.200
.100
0
.100
.200
DISTANCE IN INCHES

L. Output:

An OUTPUT for external recording or control is provided. The OUTPUT is equal to the input on the meter ranges of ±1, 2, 5 and 10 volts full scale, and precisely 1/200th of the input on meter ranges of ±20, 50, 100, 200, 500, 1000 and 2000 volts full scale. The OUTPUT is thus a ±10 volt DC source of low impedance capable of supplying an external load of 1000 ohms or greater. Front and rear OUTPUT connectors are provided. A mating connector is supplied.

M. Power Input:

117 volts ±10% 50/60 Hz, 35 watts maximum.

N. 1009 Probe Dimensions and Weight:

2 1/16" x 1 1/4" x 1 1/4" - 5.5 oz.

(Standard Model 1009A or B)

O. Probe Mounting:

* As the probe assumes the potential of the unknown in functioning, it must of necessity be insulated from ground. Insulated mounting brackets are provided with clearance holes for four 6-32 screws, two on each side of the probe assembly. (See Drawing 1009/22C.)

P. Models Available:

Single and dual channel models are available. Dual channel instruments are essentially two single channel instruments in one enclosure sharing a common ground, a common front panel meter, and a common power transformer.

Single Channel Model	Dual Channel Model	Description
144S-1	144D-1	2% Center Zero Meter
144S-2	144D-2	2% L. H. Zero Meter
144S-4	144D-4	0.5% L. H. Zero Illuminated Meter

Q. Indicator/Electronics Dimensions:

The electronics of both the single and dual channel instruments are housed behind a 7" x 19" standard rack panel which in turn is installed in a suitable cabinet. Dimensions are as follows:

Cabinet:	9 1/2" high x 20 11/16" wide x 15 3/4" deep.
Single Channel Chassis:	7" high x 19" wide x 14 3/8" deep including 2 1/2" connector.
Dual Channel Chassis:	7" high x 19" wide x 16 1/4" deep including 2 1/2" connector.

*Dependent on probe-to-surface spacing and environment. Specifications are at 0.005" spacing (unless otherwise noted) in normal laboratory atmosphere. Improvements can be obtained in controlled environments and degradation can be anticipated under exceptionally dirty or dusty conditions.

Section 2

INSTALLATION

A. Mounting 1009 Series Detector:

The probe must be mounted in close proximity to the surface area whose potential is to be monitored. For high accuracy work, the separation between the surface and the head should not exceed 1/8 inch. For less critical measurements (±1%) separations up to 1/2 inch are permissible provided a degeneration in surface resolution is permissible.

CAUTION

The overall system bandwidth is a function of overall system gain. The gain is an inverse function of the probe-to-surface separation. Consequently, excessive probe-to-surface separations will result in:

1. Decreased speed-of-response
2. Decreased surface resolution
3. Increased noise.

B. Probe-to-Surface Spacing:

CAUTION

When operating at probe-to-surface spacings of less than 0.050 inches.
*BEWARE OF PROBE-TO-SURFACE ARC OVER.

Air is subject to dielectric breakdown with the result that if the probe-to-surface spacing is low and the surface voltage is high, a destructive arc can occur.

This destructive arc can destroy the sensitive circuitry of the probe or can be damaging to the surface under test, therefore, caution is highly recommended.

REFER TO FIGURE 3 TO DETERMINE THE SAFE PROBE-TO-SURFACE SPACING FOR A GIVEN UNKNOWN VOLTAGE. 10 mils OK

for Electrotech 4-1-97 DAP

C. Insulating Detector:

*The probe itself must be mounted by means of an insulated clamp capable of withstanding voltages as high as 2000 volts with respect to ground without breakdown. This is necessary

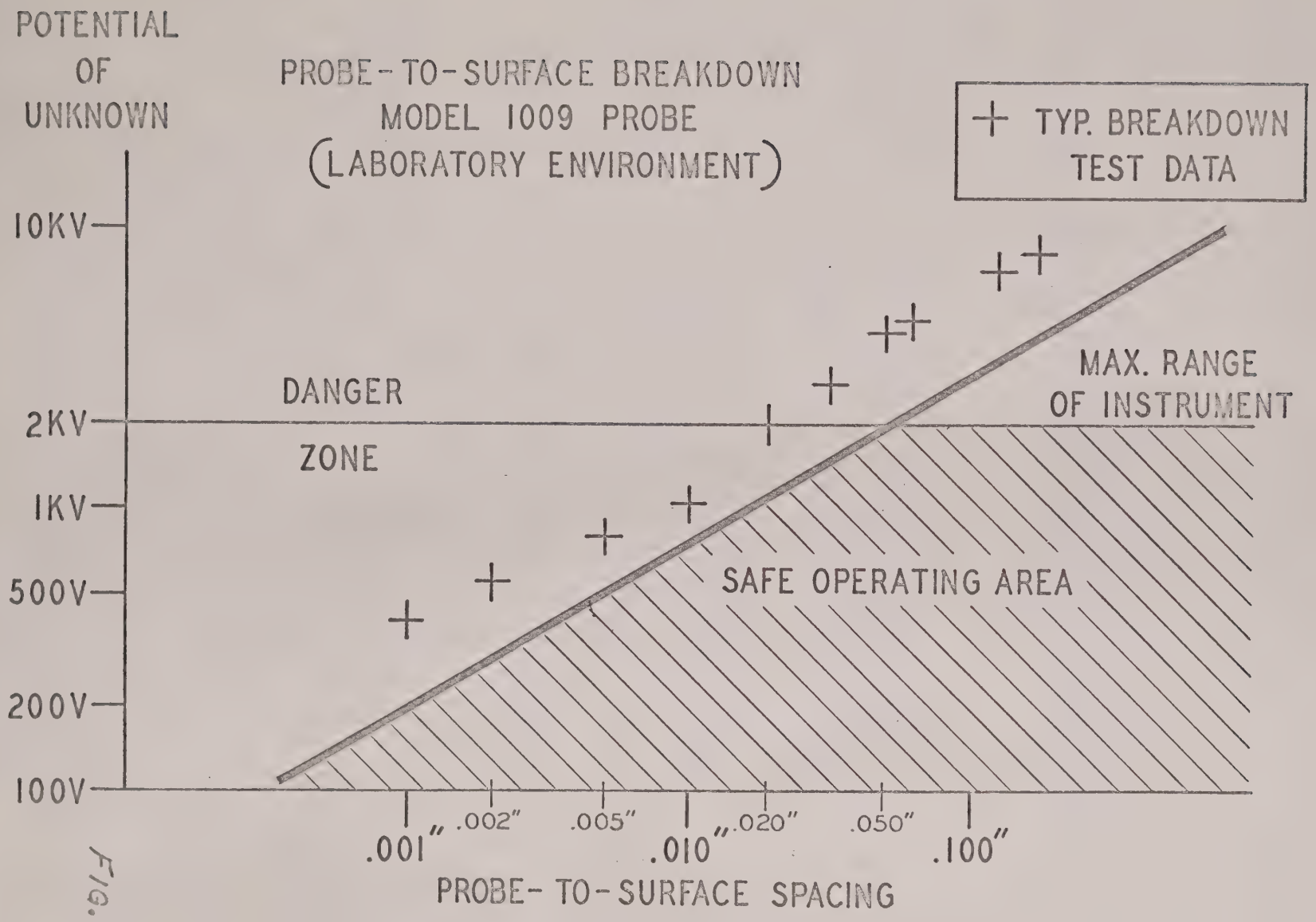

POTENTIAL OF UNKNOWN
PROBE-TO-SURFACE BREAKDOWN
MODEL 1009 PROBE
(LABORATORY ENVIRONMENT)
+ TYP. BREAKDOWN TEST DATA
10KV
2KV
1KV
500V
200V
100V
DANGER ZONE
MAX. RANGE OF INSTRUMENT
SAFE OPERATING AREA
.001"
.002"
.005"
.010"
.020"
.050"
.100"
PROBE-TO-SURFACE SPACING

FIG. 3

because this device works on a feedback principle and the probe case follows faithfully the unknown potential being measured.

D. Grounding System:

The instrument chassis is normally automatically grounded when connected to the power line. Potentials are measured with respect to ground. It is important that any "grounded" portions of the system under measurement be physically connected to the chassis of the front panel of the instrument for this purpose.

E. Output Circuitry:

The front and rear panel output connectors, J-3 and J-4, simultaneously supply an output voltage which is either equal to or precisely 1/200 th of the unknown voltage under measurement depending on the meter range selected. Output = input for meter ranges of ±10 volts full scale or less, output = 1/200th input for meter ranges of ±20 volts full scale or greater.

This signal may be utilized to drive a recorder or other device whose input resistance is 1000 ohms DC or greater.

As the equivalent output impedance is a small fraction of an ohm, the output loading effect is negligible.

The output connections are:

Pin A: Signal also Pin D: Signal in our channel systems.
Pin B: Ground Pin C: Ground

A mating connector is supplied with the instrument.

F. Remote OPERATE Switch:

Provision is made via J-2, at the rear of the chassis for a remote OPERATE switch.

External connection are as follows:

1. Connect Remote OPERATE Switch between pins A and B.

2. Connect Remote OPERATE Light (117V neon indicator) between Pins B and C if desired.

A mating connector is supplied with the instrument.

To utilize the Remote OPERATE Switch, the front panel OPERATE switch must be left in the OFF position.

Section 3

OPERATION

It is assumed that the PROBE is connected and mounted in proximity to the surface under measurement in accordance with the preceeding INSTALLATION instructions.

A. MAIN POWER Switch:

With OPERATE switch OFF, switch the MAIN POWER switch ON.

B. METER RANGE Switch:

If the front panel indicating meter is to be utilized, set the range switch to a suitable range. If the unknown is in doubt, set to the 2KV range.

Similarly, select the desired polarity.

C. OPERATE Switch:

After allowing a couple of seconds for the Probe to reach stability, the OPERATE switch may be switched ON.

D. ZERO Control:

The instrument must be zeroed with the probe looking at a grounded surface. The ZERO control is adjusted for zero output as observed on the front panel meter or external indicator for more accurate measurements.

A drift of a fraction of a volt may be observed during the first thirty minutes of operation due to thermal stabilization of the instrument.

If this drift is of no concern, the instrument may be used immediately after switching the OPERATE switch ON.

E. GAIN Control:

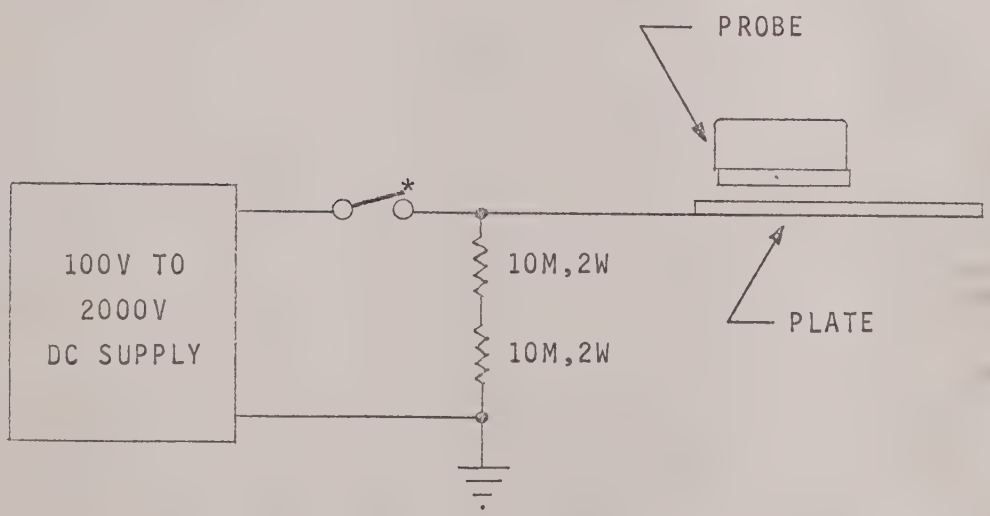
This control setting determines (a) the static accuracy and (b) the transient response of this instrument. If its setting is too low, the static error may be excessive and the speed-of-response will be sluggish. If the setting is too high, the transient response may be oscillatory or the instrument may display a sustained oscillation in the event of small probe-to-surface spacing.

NOTE: Decreasing the probe-to-surface spacing has the same influence as increasing the GAIN control. The GAIN control should, therefore, be readjusted whenever the probe-to-surface spacing is altered if optimum speed-of-response is desired.

In the event the front panel meter is the sole indicator of the instrument output, the normal static error is very small and speed-of-response is non-critical. For 1/8 inch probe-to-surface spacing, a halfway setting of the GAIN control will suffice.

In the event a high speed recorder is connected to the output, it is desirable to optimize the transient response of the instrument. The procedure is as follows:

1. Connect a DC supply through a switch to a plate at the same probe-to-surface spacing to be utilized (preferably the same surface if practicable) as shown.



*Switch with low contact bounce--preferably H.V. Reed Relay Contact.

2. Connect the OUTPUT to a recorder or scope.

3. While closing the switch, observe the instrument output and adjust for fastest speed-of-response with minimum overshoot in step response.

   Once properly adjusted, the GAIN control should require no further attention unless the probe-to-surface spacing is altered.

The static follow-up error* of a carefully zeroed and adjusted instrument is typically less than 0.1% throughout its range.

*Difference in DC potential between the unknown and the probe.

F. Probe Contamination:

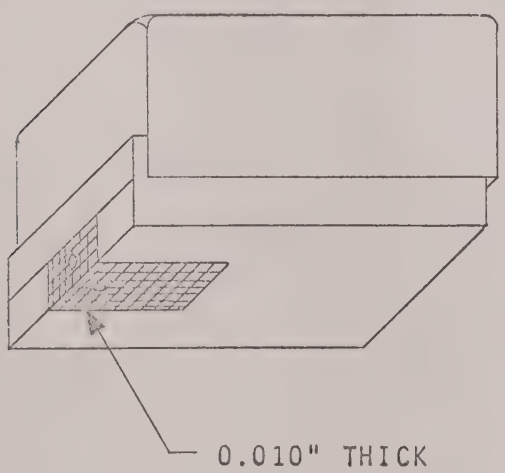
A long term uncontrollable drift will likely exist due to airborne contamination entering the sensitive volume of the probe. This airborne contamination can also produce excessive noise.

In the event that zero offset or noise becomes excessive, it will be necessary to disassemble and clean the probe in accordance with instructions in Appendix I.

In the event routine operation in a contaminated atmosphere is anticipated, the use of a gas purged probe is suggested. See Appendixes II and III.

CAUTION

THE PROBE BOTTOM PLATE THICKNESS IS ONLY 0.010" IN THE AREA OF THE SENSITIVE APERTURE. CARE SHOULD BE EXERCISED IN PROBE HANDLING TO PREVENT DAMAGE.



CAUTION

When operating dual channel instruments with only one probe, unplug the Model 371A P.C. Board (Squarer/Inverter, A-10). This will protect the high voltage transformers and other critical components from continuous arcing and eventual degradation.

Section 4

INTERNAL ADJUSTMENT PROCEDURE

A. General:

Normal operating procedure involves only the use of front panel controls as described in the previous OPERATION Section.

When facing the front of the instrument, the card cage containing P.C. (printed circuit) cards A-1 through A-10 numbered from left to right are readily accessible behind the front panel.

The referenced screwdriver adjustments are at the top of the respective P.C. cards.

B. Internal Primary Adjustments:

All adjustments in this group are stable and non-critical. They should seldom require adjustment. In the event adjustments are necessary, they should be executed in the order indicated and before performing adjustments in Section C.

1. Plus 15 Volt Supply Adjustments: 368B-15 (A-1, A-3) Boards

These supplies are factory set to 15 volts ±0.1% but any stable voltage within 15V ±5% will provide satisfactory instrument operation.

a. With the MAIN POWER and OPERATE switches "ON", connect a DC voltmeter between the pin jacks on top of the A-1 board.

b. If necessary, adjust potentiometer on A-1 (368B-15) to produce the desired voltage.

c. Similarly, monitor the voltage at the pin jacks on the A-3 (368B-15) board, and adjust its potentiometer if necessary.

2. Minus 15 Volt Supply Adjustments: 369B-15 (A-2) Board

This supply is a slave supply utilizing the +15 volt supply (A-1) for its reference. It is similarly factory adjusted to equal the +15 volt output to within ±0.1%. As above, any stable voltage within -15 volts ±5% will give satisfactory instrument performance.

a. With the MAIN POWER and OPERATE switches "ON", connect a DC voltmeter between the pin jacks on top of A-2 board.

b. If necessary, adjust potentiometer on A-2 (369B-15) to produce the desired voltage.

3. Reference Amplitude Adjustment: A-4 (Model 3011) P.C. Card

a. Position the probe above a grounded surface.

b. The reference amplitude may be monitored by measuring the DC voltage at the test points at the top of the A-6 (Model 370A-1) P.C. Card.

c. Measure the voltage with a 20,000 ohms per volt or better DC voltmeter. It should indicate 4 volts ±5%. If not, adjust the potentiometer marked "AMP" on the A-4 P.C. Card.

C. Internal Secondary Adjustments:

Adjustments in this group are independent of one another and may be executed in any order.

The instrument should be operating with the Probe aperture held at approximately 1/8 inch spacing with respect to a grounded surface unless otherwise specified.

1. Integrator Zero Adjustment: A-6 (370A-1) P.C. Card

As the output integrator amplifier has a typical open loop gain of 10^7, it is most practical to adjust its zero on a rate-of-drift basis--that is, to adjust the zero in the "open loop" condition such that the output rate-of-drift is minimized.

A zero error of approximately .1% on the 100 volt full scale range will be introduced by an integrator rate-of-drift of 25 volts-per-second. If the rate-of-drift is less than this value, the contributed error is negligible.

NOTE: This error is even less than indicated because so long as the probe-to-surface spacing is fixed and the rate-of-drift is stable, the error is automatically eliminated when the front panel ZERO adjustment is completed.

A practical method of adjusting the integrator zero is as follows:

a. Mark the proper setting of the front panel GAIN control.

b. With the indicator on the 100 volt range and with the front panel ZERO adjustment set for zero volts out, slowly reduce the GAIN control until the meter indication drifts off zero.

Reverse polarity if necessary for an on scale deflection.

c. Adjust the integrator zero adjustment (labeled ZERO on the A-6 (370A-1) P.C. Card) for zero meter deflection.

d. Continue to reduce the GAIN and adjust the INTEGRATOR ZERO control until a minimum rate-of-drift is achieved at zero GAIN.

NOTE: Should an excessive meter deflection accumulate with the GAIN at zero, it can be reset to zero by merely momentarily increasing the GAIN.

e. Return the GAIN control to its correct operating setting.

2. 60 Hz Noise Trimmers: A-6 (370A-1) P.C. Card

Two adjustments on the 370A card labeled R BAL and C BAL permit nulling the 60 Hz sinusoidal component of OUTPUT noise.

There is some interaction between the front panel GAIN setting and these adjustments; therefore, optimal results will be achieved with the GAIN control set for correct transient response at the operating probe-to-surface spacing. Adequate results for most circumstances are achieved with a 50% GAIN setting.

Proceed as follows:

a. Connect an AC VTVM or scope to the instrument OUTPUT.

b. Alternately adjust the R BAL and C BAL as necessary to minimize the sinusoidal noise.

3. Output Calibration: (R-111)

This control is located at the right of the rear panel of the chassis and is labeled CAL. It adjusts the instrument OUTPUT to a precise 1/200th of its input.

The attenuation network (R-110 and R-111) is of necessity a carbon film network which is temperature compensated but one which can be expected to drift slowly with age. Its setting should, therefore, be checked annually to achieve most accurate instrument performance.

The instrument should be set up with a test plate at a typical probe-to-surface spacing and with the front panel

GAIN and ZERO adjustments performed as outlined under OPERATION.

To complete this setting to 0.1% accuracy, a .05% or better DC Voltmeter should be employed.

A typical procedure is as follows:

a. With the test plate grounded, carefully adjust the OUTPUT to zero volts to better than one millivolt.

b. Apply +200 to +1000 volts to the test plate utilizing a stable, well regulated power supply set to an accuracy of 0.05% or better.

CAUTION

THE USE OF A POORLY REGULATED REFERENCE SUPPLY CAN RESULT IN AN ERROR IN THE INPUT VOLTAGE WHEN THE LOADING OF THE MEASURING VOLTMETER IS REMOVED.

c. Measure the OUTPUT and adjust CAL as necessary to achieve an output voltage equal precisely to 1/200th of the input, for example:

INPUT	OUTPUT
1000.0 V	5.000 V
500.0 V	2.500 V
200.0 V	1.000 V

Section 5

THEORY

Basic Principle:

Please refer to the adjacent block diagram (Drawing 144/12.)

The electrostatic electrode "looks" at the surface under measurement through a small hole at the base of the probe assembly. The chopped AC signal induced on this electrode is proportional to the differential voltage between the surface under measurement and the probe assembly. Its phase is dictated by the DC polarity.

The reference voltage and this mechanically modulated signal, conditioned by the high input impedance preamplifier and signal amplifier are fed through isolation transformers to the phase sensitive detector whose output DC amplitude and polarity are dictated by the amplitude and phase of the electrostatically induced signal relative to the reference signal. The output of the phase sensitive detector feeds a high level DC integrating amplifier. The output of the integrating amplifier, whose polarity is identical to the unknown, is fed directly to the probe.

As the open loop gain from probe to integrator is extremely high (approximately 10^9) the probe is driven to a DC voltage typically within 0.01% of the potential of the unknown for 1/8 inch probe-to-surface spacing. By simply metering the output of the DC integrating amplifier, one has an accurate indication of the unknown potential.

The instrument's finite input impedance is attributable only to ionic conduction in the atmosphere.

General Theory:

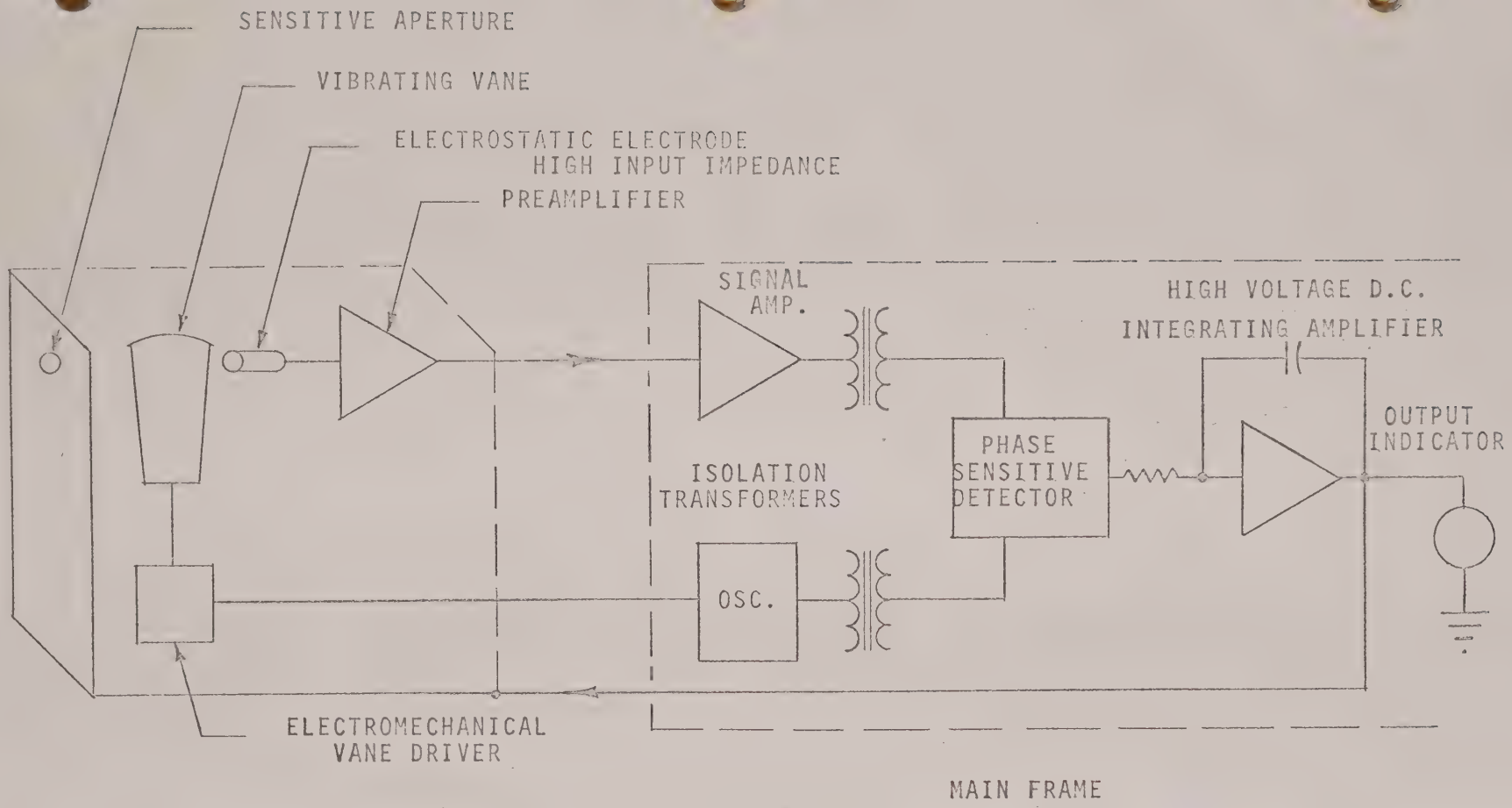
The following specific theory applies to the Model 144 Series ISOPROBE® Electrostatic Voltmeter. The Models 144S (Single Channel) and 144D (Dual Channel) instruments are essentially identical. The Model 144D differs from the 144S as follows:

1. A single power transformer (T-102) is employed to feed the + and - 15 Volt regulators (A-1 and A-2) of both channels.

2. A single front panel indicating meter is employed for both channels with suitable range and channel switching.

The dual channel instrument is otherwise two single channel instruments sharing a common enclosure and a common ground.

For purposes of illustration we shall, therefore, restrict our



ISOPROBE* ELECTROSTATIC VOLTMETER

* Registered Trademark

		SCALE		DATE	MONROE ELECTRONICS, Inc. ENGLEWOOD, N. Y.
		DRAWN	JA	65-67	
		CH'KD.			MODEL 144 BLOCK DIAGRAM
NEXT ASSEMBLY	NO. REQ.	APP'D			
TOLERANCE UNLESS OTHERWISE SPECIFIED: DECIMAL ± .005 FRACTIONAL = 1/64 ANGULAR ± 15'					144/12

theory discussion to the single channel instrument.

A. Model 1009A and B Probe:

The Models 1009A and B are electrically identical.

1. Model 1009A:

The Model 1009A has the sensitive aperture located on the bottom of the probe, 5/32 inches from one end, centered.

2. Model 1009B:

The Model 1009B has the sensitive aperture located on the end of the probe, 1/8 inch up from the bottom, centered.

3. Sensitive Electrode:

A 0.070 inch hole is located in the bottom plate of the probe such that its opening is "chopped" by the vibrating vane. Aligned axially with the hole is a sensitive electrode whose electrostatically induced voltage feeds the unity voltage gain preamplifier input.

4. Signal Preamplifier:

The sensitive electrode feeds the premaplifier which is a unity voltage gain non-inverting wide band AC amplifier with an input resistance of approximately 1000 megohms and low input capacitance. High input impedance is achieved through the use of an F.E.T.

Should a DC potential difference exist between the unknown surface-under-test and the vibrating vane, a signal would be induced at the preamplifier input due to the capacitance modulation of the vane. This signal frequency would be approximately 705 Hz. At this frequency, the source capacitance reactance of the probe would be low compared to its resistive component.

5. Contact Potential:

All sensitive components of the electrostatic chopper are gold plated in an effort to minimize contact potential. In spite of this, residual contact potentials will generally exist as it is impossible for this probe to function with long term DC stability in the presence of an intervening insulating window to keep out contamination.

As contamination due to outside impurities entering the sensitive volume cannot be avoided, provision is made via

the "zero" control to buck out their effect. This is accomplished by feeding a DC potential, adjustable in amplitude and polarity with respect to the probe frame, to the sensitive electrode while the vibrating vane is connected to the probe frame.

Contact potential effects are, therefore, bucked out by adjusting the output to zero when the probe is looking at a grounded surface.

B. Model 3011 Oscillator Board:

1. Vibrating Vane Oscillator Signal:

The Model 3011 Oscillator Board provides a driving signal directly to the vibrating vane circuitry in the Model 1009 Probe. The amplitude of vibration is controlled by the amplitude of this signal.

2. Reference Signal:

The Model 3011 Oscillator Board also provides a reference signal to the Model 370A-1 Phase Sensitive Detector (Pin 10).

3. Zero Control:

A single +15 volt regulated supply (Model 368B-15, A-3) powers all off ground circuitry including the Probe, Oscillator (Model 3011, A-4) and Signal Amplifier (Model 3010, A-5). The common negative bus for this supply is adjusted relative to the Model 1009 case potential by the use of the ZERO control, R-101. This permits bucking out of residual contact potential as described above.

AC potentials are bypassed to the case to minimize noise pickup.

C. Model 3010 Signal Amplifier Board:

The Model 3010 Signal Amplifier Board is provided to amplify the signal voltage produced by the 1009 Probe.

It will be noted that the signal is fed via the GAIN potentiometer (R-102) which permits setting the signal gain and establishing optimized transient response for the closed loop system.

D. Isolation Transformers:

All the aforementioned circuitry is driven off ground to follow the unknown input potential and therefore, can be at any

DC potential in the range of ±2000 volts.

The oscillator reference and signal amplifier outputs must be made available with reference to ground potential, hence isolation transformers T-103 and T-104 are employed.

E. Model 370A-1 Phase Sensitive Detector:

Please refer to the Model 370A-1 Phase Sensitive Detector schematic (Drawing 370A-1/1) at the rear of the manual.

Note the constant reference voltage feeds pins 4 and 7 of the module and, therefore, generates a constant DC voltage across C-3 and, therefore, between J-1 and J-2. This voltage serves to set or check the reference voltage amplitude.

The signal voltage should normally be either in phase or in phase opposition relative to the reference voltage.

If the signal voltage is zero, J-1 and J-2 should be equal in magnitude and opposite in polarity relative to ground. The arm of the integrator ZERO control, R-10 should, therefore, be at a balance point permitting no current to flow to ground in the event of a short circuit to ground.

If we now assume a signal of one volt peak amplitude which is in phase with the reference voltage feeding pin 4 and in phase opposition to the reference voltage feeding pin 7, the DC potential of J-1 will increase one volt while that of J-2 will decrease one volt.

A short circuit current derived from the voltage of J-1 via R-9 of approximately 10 microamperes will flow. Similarly a current of 10 microamperes derived from J-2 via R-11 will flow providing a total of 20 microamperes of short circuit current.

Should the phase of the signal voltage be reversed, the same short circuit current but of opposite polarity will flow.

The output from the Phase Sensitive Detector can then be a current whose magnitude is linearly related to the peak signal amplitude and whose polarity reverses with phase reversal.

F. 60 Cycle Noise Rejection:

This PC board (370A-1) which includes the Phase Sensitive Detector as its major circuitry, basically provides all input circuitry for the high voltage integrating amplifier. In the fedback condition, the output impedance of the integrator is low but finite. Various sources of 60 cycle noise are injected by stray capacitance and leakage into the integrator output which would best be minimized. This noise is conveniently

minimized by purposely injecting into the integrator input, 60 cycle currents both in phase and in phase quadrature which are adjustable in amplitude and capable of phase reversal.

These adjustments are available as the R BAL and C BAL adjustments and permit nulling the 60 cycle component of output noise.

G. High Voltage Integrator:

The high voltage integrator is composed of the following components:

1. Model 353B-4C Low Level Operational Amplifier
2. Model 373A-2 Booster Amplifier
3. Model 371A Squarer/Inverter
4. Step-up Transformers
5. Model 405 H.V. Demodulator
6. Integrating Capacitor, C-106.

1. Model 353B-4C Operational Amplifier:

This amplifier exhibits low input voltage and current drift, a ±10V ±20mA output current capability and a typical voltage gain of 50,000. Its output feeds the 373A-2 Booster.

2. Model 373A-2 Booster Amplifier:

This amplifier is capable of ±250mA output current and a slight non-inverting voltage gain. Its output feeds the Model 371A Squarer/Inverter.

3. Model 371A Squarer/Inverter:

Please refer to Schematic 371A/1 at the rear of the manual.

Q-2 and Q-3 constitute a multivibrator which, in the presence of a synchronizing signal, operates at about 1K Hz and supplies drive to the switching transistors in the following inverter.

The synchronized frequency of the multivibrator is 1K Hz. Stable synchronizing pulses are obtained from the pulse generating circuit consisting of Q_1, R_1, R_2, C_1, R_3 and R_4. Q_1, a UJT (uni-junction transistor), produces short duration 5.0 volts positive pulses across R_4. This pulse is coupled to the bases of Q_2 and Q_3 via R_5 and R_6, thereby, switching the non-conducting transistor on. The frequency of the pulses, which is determined by the time constant of R_1, R_2 and C_1, is twice that of the desired synchronized frequency. This ensures that each cycle of

the inverter frequency is produced by two successive synchronizing pulses from the UJT thereby, producing a 50% duty cycle square wave at the primary of T_1.

Two identical inverter circuits will be observed composed of Q-4 and Q-5 in one case and Q-6 and Q-7 in the other. By referring to the 371A schematic and the 144 schematic, it will be observed that these inverters are series connected between the +15 volt and -15 volt supplies. Their midpoint connection is in turn fed from the output of the booster amplifier.

If the output of the booster is zero, each inverter converts its 15 volts DC into a 15 volt square wave. This 15 volt square wave is stepped up by the transformer connected to the inverter collectors by a ratio of 200:1. Its output is, therefore, a 3000 volt square wave.

5. Model 405 H.V. Demodulator:

The two square waves from each inverter transformer secondary are fed to the Model 405 Demodulator which provides an output DC proportional to the difference in amplitude of the high voltage square wave inputs.

6. Integrating Capacitor, C-106:

The feedback loop of the integrator is closed via C-106, the integrating capacitor, thus converting the high gain amplifier whose open loop gain is approximately 10^7 into an integrator.

H. Feedback:

The output of the integrator, (the Model 405 H.V. Demodulator), will be observed to be fed back to the case of the Probe.

This output thus functions to faithfully follow the DC potential of the unknown being measured. The static accuracy with which the instrument follows the unknown is normally better than 0.01%.

I. Output and Metering:

To achieve best accuracy and stability, the High Voltage output from this device when operating at or above 20 volts full scale is not used directly as an output but rather is attenuated by a high resistance, temperature compensated attenuator, R-110, and fed to A-9, a Model 353B-4BSP Operational Amplifier connected as a precision voltage follower. As the linear output range of the operational amplifier is ±10 volts maximum, an attenuation factor of 200:1 is dictated. This ratio is set precisely by R-111.

The amplifier output is of very low impedance (typically less than 0.1 ohms) with the result loading errors are negligible and both the recorder and meter can be utilized simultaneously.

The meter range, as a result of this attenuation, is in reality 10 volts full scale on the 2KV range and 0.1 volts full scale on the 20 volt range.

When operating at or below 10 volts full scale, the integrator output is fed directly to the Model 353B-4BSP amplifier.

J. Model 368B-15 Plus 15 Volt Regulated Power Supply: (A-1 and A-3)

Two of these supplies are employed, one to supply positive +15 volt regulated and +28 volt unregulated power with reference to ground (A-1), and the second to supply floating +15 volt regulated power to the input circuitry (A-3).

Please refer to the Main Schematic 144S/1. You will note that A-1 is fed by T-102, a 34 volt center tapped transformer that simultaneously supplies power to A-2, the -15 volt supply. Similarly, A-3 is fed by T-101, a separate 34 volt center tapped transformer. The center tap of T-102 is grounded while that of T-101 is floating.

Please refer to the P.C. Card Schematic 368B/1.

1. Rectifier/Filter:

   The transformer center tap is fed to pin 1, while the transformer ends feed pins 9 and 10. It is, therefore, apparent that rectifiers CR-1 and CR-2 feed full wave rectified current to C-1, the filter capacitor. The output from C-1 feeds pin 7, thus supplying +28 volt unregulated output from the card.

2. Current Limiter:

   R-1, R-2, and Q-1 function as a constant current limiter which limits the output current to a value slightly in excess of the supply's 250 mA rating to protect the circuitry against overload or short circuit.

3. Reference:

   CR-4 functions as the voltage reference for the supply.

4. Sensing Amplifier:

   Q-6 and Q-8 function as the differential input pair comparing the reference voltage with the attenuated output voltage. Q-5 is cascade connected to Q-6 to improve line voltage regulation. Q-2, CR-3, R-4 and R-5 function as a

temperature compensated direct coupled inverter such that the common collector connection between Q-2 and Q-8 constitute the sensing amplifier output which exhibits good DC stability and high voltage gain when feeding a high impedance load.

5. Output Amplifier:

Q-7 together with Darlington connected Q-3 and Q-4 form a unity gain, high current, non-inverting amplifier. R-11 insures power supply start up.

This regulator exhibits excellent line and load regulation (better than 0.01%) low noise, and excellent transient recovering characteristics.

K. Model 369B-15 Minus 15 Volt Regulated Power Supply: (A-2)

One of these supplies is employed to supply -15 volt regulated power and -28 volt unregulated power in position A-2.

Its power is derived from T-102 as described above.

Please refer to Schematic 369B/1 at the rear of the manual.

This supply will be observed to be almost identical to the Model 368B-15 except as follows:

1. As it provides a negative output in reference to the same common ground, all semiconductors are of the opposite polarity, e.g. Q-6 and Q-8 are PNP's in the 369 as compared with NPN's in the 368.

2. The Model 369 is a slave supply - that is, it uses the 368 as its voltage reference and its output is equal to that of the 368 but of opposite polarity.

3. Its capabilities are essentially identical to those of the Model 368.

Section 6

MAINTENANCE

Normal maintenance for this instrument should be limited to periodic cleaning and adjustments as described in the preceding section.

In the event of a catastrophic failure, it will more than likely occur in a plug-in module.

Replacement modules are available at the factory. Factory repair of defective modules is recommended as many components employed in these modules are selected.

Listed as follows are replacement plug-in modules with their purchase and repair prices.

MODEL 144 PARTS AND ACCESSORIES

The following is a complete list of Model 144 interchangeable replacement parts and modules. The flat repair price after the warranty period is 1/2 of the indicated part price for Items 1 through 9. Item 10 is not repairable. Item 11 is repaired on a time and material basis only.

Item No.	Model No.	Description	Quantity Per Instrument	Price
1	353B-4C	Operational Amplifier	1	$ 75.00
2	353B-4BSP	Operational Amplifier	1	71.00
3	368B/15	+15 Volt Power Supply	2	72.00
4	369B/15	-15 Volt Power Supply	1	64.00
5	370A-1	Phase Sensitive Detector	1	58.00
6	371A	Squarer/Inverter	1	165.00
7	3010	Signal Amplifier	1	110.00
8	373A-2	Power Booster	1	103.00
9	3011	Oscillator	1	154.00
10	405	High Voltage Module	1	285.00
11	1009A or B	Standard Probe	1	825.00
12	302A	Extension Circuit Board Accessory		16.50

The recommended interchangeable and exchangeable units for maintenance purposes would include 1 each of the following:

353B-4C, 353B-4BSP, 368B/15, 369B/15, 370A-1, 371A, 3010, 373A-2, 3011 and possibly also an additional probe Model 1009A or B.

All prices are F.O.B. factory, Middleport, New York 14105.

Prices and specifications are subject to change without notice.

APPENDIX I

DISASSEMBLY AND CLEANING OF MODEL 1009 PROBE

A. General:

It is impossible for the sensitive aperture at the base of the Detector/Preamplifier to be covered by a window of any sort and to continue to operate normally.

So long as this aperture is open, foreign materials may enter the volume associated with the vibrating vane and generate undesired noise or DC offset thereby impairing the accuracy and utility of the instrument.

To maintain low noise and low offset, it is important that the probe be operated in as clean an atmosphere as practicable and that it be periodically disassembled and cleaned.

Where practicable it is recommended that:

1. The probe be installed with the sensitive aperture downward.

2. When not in use, the sensitive aperture be sealed with a suitable pressure sensitive tape such as masking tape, taking care that the adhesive does not come into direct contact with the aperture.

3. When the probe must be operated in a contaminated atmosphere (chemical or airborne physical contamination) it is recommended that the 1009AG or 1009BG Gas Purged Probe be employed. This probe is continuously purged with clean filtered air to prevent contamination. (See Appendix II and III.)

The necessity for cleaning is indicated when:

1. The output as indicated by the meter or the recorded record is excessively noisy.

2. It is no longer possible to "zero" the instrument using the "zero" adjustment.

3. The instrument's zero becomes sensitive to probe-to-surface spacing when looking at ground.

B. Cleaning of Probe:

Procedure 1:

a. Disconnect cord from Main Unit.

b. Remove four recessed screws from bottom plate. (Use EXTREME CAUTION in removing bottom plate. Move away directly, rather than sliding, to prevent damage to vanes.)

c. Once the bottom plate is removed and until it is replaced, the two vanes are exposed and subject to damage, therefore, during cleaning, VERY CAREFUL HANDLING is required.

d. Cleaning should be done with MILLER-STEPHENSON MS-180 FREON TF degreaser, or with a soft camel hair brush and ethyl or isopropyl alcohol.

e. Areas to be checked for cleanliness are:

. Sensitive Electrode

Two vanes

The Aperture opening and surrounding area on bottom plate.

f. When replacing the bottom plate EXTREME CAUTION should be used.

Procedure 2: (If an ultrasonic cleaner is available)

a. Disconnect cord from Main Unit.

b. Remove set screw from bottom plate. (Just below cable entry.)

c. Put unit into ultrasonic cleaner.

NOTE: Cleaning solvent to be CLEAN ethyl or isopropyl alcohol.

d. Clean unit until no dirt is visible in aperture hole.

e. Replace set screw in bottom plate.

f. Reconnect cord to Main Unit.

APPENDIX II

INSTALLATION INSTRUCTIONS FOR GAS PURGE KIT

1. Remove Allen set screw from probe (Model 1009A or 1009B). This set screw is located directly beneath the cable exit at the rear of the probe.

2. Insert the purge tube (small threaded metal tube) in the hole from which the Allen set screw was removed.

3. The length of TYGON® plastic tubing supplied with kit must be cut into two pieces, the length of which will be determined by the relative placement of the air pump, air purifier/flow equalizer, and the probe; the air purifier/flow equalizer being connected between the air pump and the probe.

4. Attach one brass fitting (supplied with kit) to each length of TYGON® tubing.

5. Connect one length of tubing to each end of the air purifier/flow equalizer (via attached fittings).

6. Fit one free end of the plastic tubing over the air pump exhaust (small tube on air pump opposite line cord).

7. Fit the remaining free end of the plastic tubing over the purge tube (attached to probe).

8. Apparatus is now ready for operation.

APPENDIX III

OPERATION INSTRUCTIONS FOR GAS PURGED PROBE

1. Install apparatus as outlined in "Appendix II". Mount probe as necessary.

2. Connect air pump to source of 110 volt alternating current (AC) only.

3. For maximum air flow, turn adjusting thumbscrew (on top of air pump) clockwise until a rattling noise is heard and then turn counter-clockwise 1/2 turn. DO NOT OPERATE PUMP WITH ADJUSTING THUMBSCREW TURNED DOWN PAST RATTLING NOISE.

4. A positive air pressure is now maintained at the probe.

5. For best results, leave the pump in continuous operation.

6. When the pump is disconnected, cover the sensitive aperture with tape to seal the opening against external contamination.

7. The useful life of the air purifier/flow equalizer will be dependent upon individual conditions. Deterioration may be most noticeably observed as gradual degradation in performance of the ISOPROBE® Electrostatic Voltmeter due to contaminants entering the probe through the purging system.

8. Under normal laboratory conditions, replacement is recommended annually.

9. Replacement air purifier/flow equalizer units may be obtained at $7.90 each from Monroe Electronics, Inc.

10. The air pump is guaranteed by the manufacturer. The guarantee may be validated by complying with the terms set forth on the guarantee registration form.

APPENDIX IV

MODEL 1009/22D GRADIENT ADAPTER

A. Description:

The Model 1009/22D Gradient Adapter is an accessory to the Monroe Electronics Model 144 ISOPROBE® Electrostatic Voltmeter which permits its use as an electrostatic fieldmeter with direct readout in volts per millimeter of probe-to-surface separation. The adapter consists of a box constructed of insulating material whose outside dimensions are 3 1/8 inches long, 1 3/4 inches wide, and 1 3/4 inches high with a gold plated bottom plate and calibrating and clamping screws for the Model 1009A Probe. Mounting provisions are provided in the form of two #6-32 tapped holes on 1 1/4 inch centers on each side of the enclosure.

B. Initial Installation:

Initial installation of the Model 1009/22D Gradient Adapter on the Model 1009A (bottom viewing) Probe is as follows:

1. Loosen the locknuts on the nylon calibrating and locking setscrews on the front and rear (respectively) of the adapter. (Fig. 1)

2. Loosen the two #4-40 captive screws near the bottom edge of the rear panel.

3. Slide out the rear and top panels as a unit.

4. Place the Model 1009A Probe in the slot provided in the inside of bottom panel of the adapter so that the aperture in the probe falls approximately over the aperture in the bottom plate of the adapter and press forward against the calibrating setscrew. Turn the setscrew in such a direction as to align the front of the probe aperture tangent to the front of the (adapter bottom plate) aperture.

5. Replace the rear and top panel unit, retracting the locking setscrew as necessary. Reinstall the two #4-40 captive screws loosened in step #2.

   The adapter is now prepared for calibration.

C. Calibration:

The adapter may be calibrated as follows:

1. Support the adapter containing the probe with its bottom plate parallel to and precisely one centimeter from a large, flat metal surface which is insulated from ground sufficiently to withstand a DC potential of 1000 volts. Support should be from above, if possible. The #6-32 screws used to mount the adapter should be only as long as necessary to extend to the inside of the 1/8 inch thick wall of the adapter as the probe is capable of ±2000 volts with reference to chassis ground.

2. Connect the bottom plate of the adapter via the wire exiting from the rear of the adapter to the "GRD" binding post on the front panel of the Model 144.

3. Temporarily connect the metal plate at which the probe/adapter is "looking" to chassis ground.

4. Energize "main power" and "operate" switches on the front panel of the Model 144 Voltmeter.

5. Advance "gain" to fully clockwise position.

6. Zero Model 144 on 20 volt range using front panel "zero" control.

7. Set range selector switch to +100 volt range.

8. Connect a calibrating source of precisely +1000 volts DC to the plate at which the probe/adapter is "looking". The front panel meter responds "directly in volts-per-millimeter" and should indicate less than +100 V/mm.

9. Observing adequate caution, turn the nylon locking setscrew at the rear of the adapter clockwise until it contacts the rear of the probe and back off three complete turns in the counter-clockwise direction.

10. While observing the front panel meter on the Model 144 Voltmeter, turn the nylon calibrating setscrew at the front of the adapter clockwise until the front panel meter indicates approximately +95 V/mm.

11. Return the plate under the probe/adapter to chassis potential and rezero the Model 144 Voltmeter, if necessary, on the 20 volt range using the front panel "zero" control. Switch back to the +100 V range.

12. Again apply precisely +1000 volts to the plate under the probe/adapter and continue to turn the nylon calibrating setscrew clockwise until the front panel meter indicates precisely +100 V/mm.

13. Turn the nylon setscrew clockwise as necessary to lock the probe in position inside the adapter. Set the locknuts on both nylon setscrews to lock them in place.

    The adapter is now properly calibrated.

D. Removal and Subsequent Reinstallation of Adapter:

The adapter may be calibrated for use with a specific 1009A Probe and be expected to remain calibrated when removed from and reinstalled on the same probe in accordance with the following procedure:

1. To remove probe:

    a. Loosen the two #4-40 captive screws near the bottom edge of the rear panel.

    b. Slide out the rear and top panels as a unit.

    c. Remove the probe.

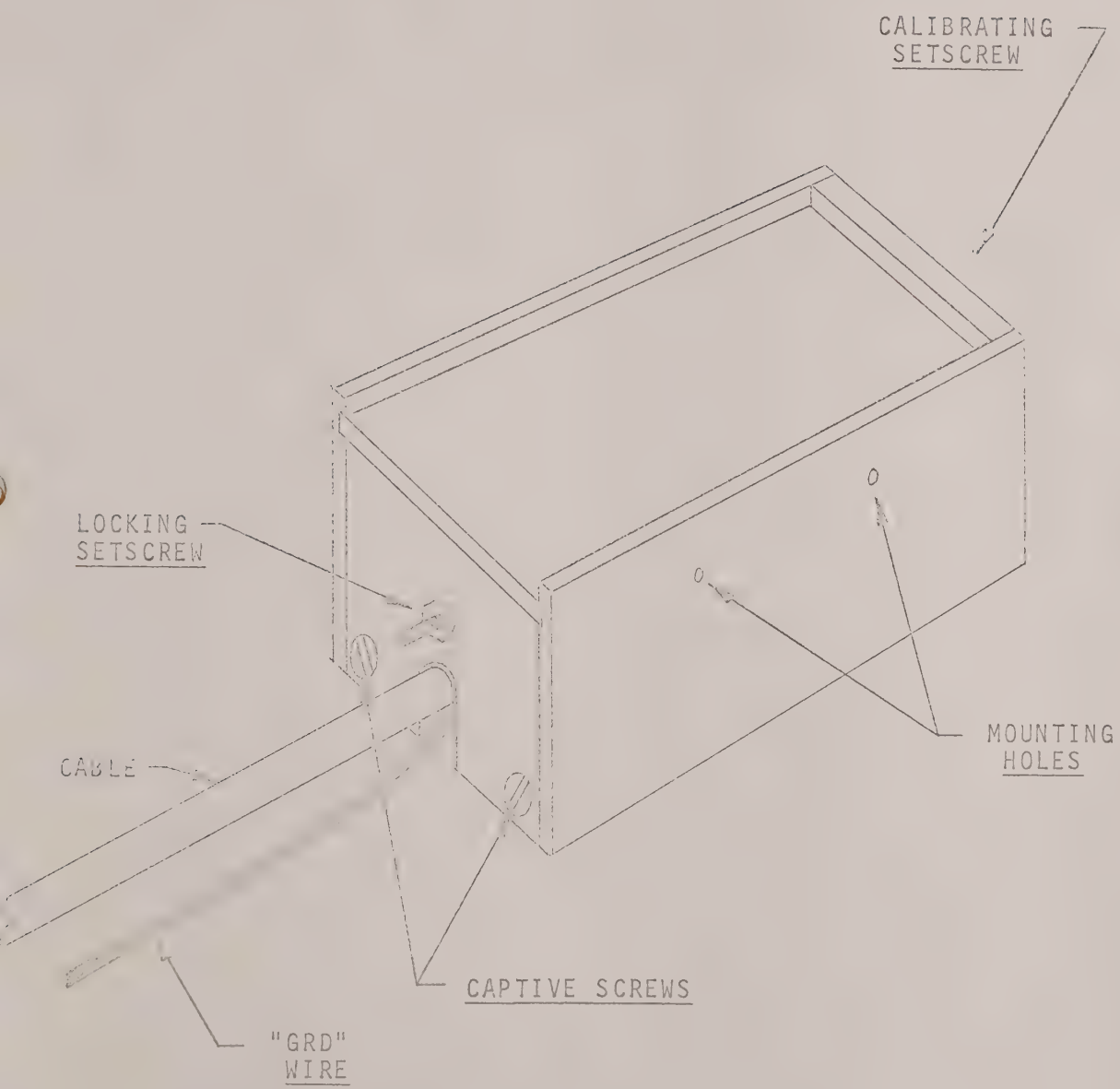
2. To reinstall probe:

    a. Place probe in adapter and slide forward until probe contacts nylon calibrating setscrew.

    b. Replace the rear and top panel unit and reinstall the two #4-40 captive screws.

1009/22D

Fig. 1



1009C

APPENDIX V

MODEL 1009C HIGH RESOLUTION PROBE

A. General:

The Model 1009C High Resolution Probe is electrically identical and similar in mechanical design to Model 1009B end viewing probe. It is capable of improved surface resolution but at a sacrifice in response speed and an increase in noise.

B. Mounting:

The probe must be mounted in close proximity to the surface to be monitored to be most effective. Separations of approximately 0.005" to 0.050" are recommended, subject to normal precautionary measures.

A kit of mounting insulators (1009/22K) is furnished with each probe.

C. Precautions:

Due to decreased sensitivity of the Model 1009C Probe, the front panel zero control has a much greater than normal range and is capable of causing the probe to be driven to voltages which may cause destructive breakdown to the surface under test at very close separation. It is recommended, therefore, that initial zeroing efforts be made with the probe "looking" at a grounded surface from a distance of at least 0.050.

Consult section 2-B, "Probe-to-Surface Spacing" in Model 144 ISOPROBE® Electrostatic Voltmeter instruction book.

D. Accessory Purge Kit Model "G":

Use of accessory purge kit Model "G" is advised with Model 1009C Probe to reduce zero offset due to solid and gaseous contamination.

E. Model 3010-1 High Gain Signal Amplifier:

Use of the special high gain amplifier will significantly improve the speed-of-response of the Model 144 when used with the Model 1009C High Resolution Probe. The Model 3010-1 is available from Monroe Electronics, Inc. for $127.00.

F. General Operation:

The following comments may assist the user:

1. The front panel gain control may normally be operated in its fully clockwise position.

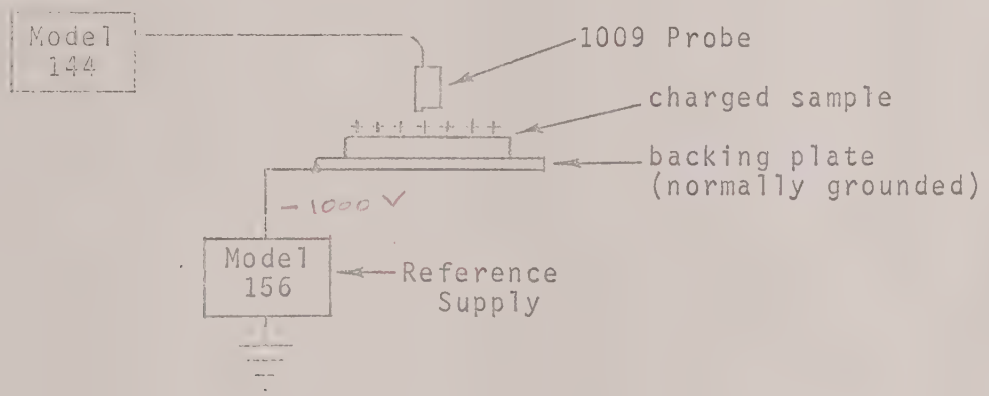
2. Integrator zero adjustment must be very carefully executed after adequate thermal stabilization to minimize drift in long term measurements.

3. Use on the 10 volt and lower ranges is not generally practical.

APPENDIX VI

MEASUREMENT OF SURFACE POTENTIALS
Greater than 2000 VDC using the
Model 144 ISOPROBE® Electrostatic Voltmeter
Method #1

For many applications, the range of the Model 144 ISOPROBE® Electrostatic Voltmeter may be varied from ±2000 VDC by using a suitable reference supply such as the Model 156 ±2KV Reference Supply. The technique is very simple: instead of measuring the potential of the sample with respect to ground, measurement is made with respect to any convenient potential as established by the reference supply.



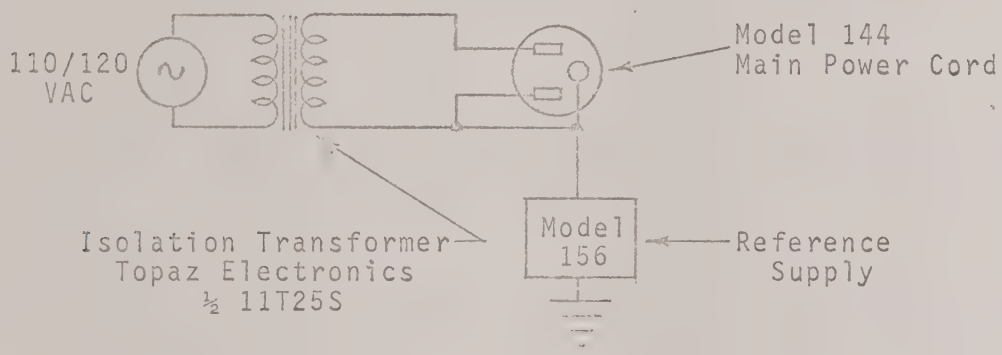
If, for example, -1KV is applied to the backing plate as shown in the sketch, then the range of the Model 144 ISOPROBE® Electrostatic Voltmeter when measuring the sample shown is from -1000 to +3000 VDC. (The potential applied to the backing plate is simply subtracted from the meter reading of the Voltmeter.)

It is often cumbersome to raise the backing plate potential from ground and, having done so, it is quite possible for an unwary technician to get a severe shock by inadvertently touching an unrounded piece of the apparatus. The Model 156 ±2KV Reference Supply is very well suited to this application because its output current is limited to <500μA, a level considered to be generally safe. The current limit of the Model 156 does not prevent a shock entirely but it does significantly limit its severity.

Although the Model 156 is accurate to only 0.5% of its setting, it is not difficult to maintain the accuracy of the measurement at 0.1% by simply measuring the exact output of the Model 156, using the Model 144, before proceeding with a sample.

Method #2

This application note describes an additional method for varying the range of the Model 144 ISOPROBE® Electrostatic Voltmeter to allow measurement of surface potentials in excess of 2000 VDC. This method is usable in those situations where it is either not feasible or not convenient to raise the potential of the normally grounded sample backing plate, but where it is possible to float the entire chassis of the Model 144 to some high potential.



In the above sketch, the Model 144 will measure thr potential of a charged sample with respect to whatever voltage is set on the reference supply instead of with respect to ground. If, for example, +1000 VDC is set on the Model 156 ±2KV Reference Supply, it is possible to measure samples in the range of -1000 to +3000 VDC. (The potential applied to the chassis of the Model 144 is simply added to the meter reading.)

As is the case in Method #1, applying a high voltage to a usually grounded piece of apparatus presents a possible safety hazard to personnel. Use of Monroe Electronics Model 156 ±2KV Reference Supply is again recommended as the high voltage source because of its output current limit of <500μA, a level considered to be generally safe.

The Topaz Electronics Transformer suggested above is well suited to this application because of its extremely low primary to secondary capacitance (.005pF) and very low leakage to ground (>10,000MΩ). If a different transformer is selected, these parameters, as well as the voltage rating, must be taken into account.

APPENDIX VII

MODEL 1012 "MINI" PROBE

A. General:

The Model 1012 "Mini" Probe is designed for use with any Model 144 ISOPROBE® Electrostatic Voltmeter, or any Model 138 Feedback Electrostatic Voltmeter equipped with a Model K-138/1009 Miniature Probe Modification Kit. The probe includes a pre-amplifier and a special oscillator, both of which are contained in a small box built into the probe cable, and a special Model 3010-2 Signal Amplifier which must be installed in the Model 144 when using the probe. Additionally, a Model 1012/52 side viewing adapter is supplied with each probe to provide greater versatility and adaptability to special mounting requirements.

B. Installation:

1. Insert the Model 3010-2 into the Model 144 in place of the standard Model 3010 Amplifier (card A-5).

2. Plug the probe into the Model 144 using the standard probe connector.

3. The side viewing adapter may be used if desired by simply unscrewing (counterclockwise) the standard end cap and screwing on the adapter.

4. Continue as discussed in Section 2.

5. A gas purge kit (if desired) attaches to the small tube already installed on the amplifier/oscillator box.

C. Operation:

The Model 1012 "Mini" Probes are used just like the standard Model 1009 Probes. There are, however, two peculiarities that might be observed in their use:

1. There is a slight "blip" in the transient response characteristic. It occurs well within the 30 millisecond 10% to 90% response time, and thus has no influence on the usefullness of the instrument. It can, in fact, only be observed if an oscilloscope is connected to the output during a step change in the potential of the surface under measurement.

2. When using a Model 1012 the instrument system may oscillate if the gain control is set too high.

If any other peculiarities or difficulties are encountered, please contact the factory for assistance.

APPENDIX VIII

SMALL SIGNAL MEASUREMENTS

A. Purpose:

To provide an adjustment technique for the Model 144 ISOPROBE® Electrostatic Voltmeter for maximum insensitivity to probe-to-surface spacing variations — especially with regard to use of the instrument at the 10 VFS range and below.

B. General:

The basic measurement principle employed in the Model 144 ISOPROBE® Electrostatic Voltmeter is "field nulling" by means of driving the probe housing to the same potential as the surface undergoing measurement. This technique is intrinsically insensitive to variations in probe-to-surface spacing since the electric field between two surfaces is zero if the surfaces are at the same potential, regardless of the distance between them.

This ideal circumstance neglects the effects of "error signals" induced on the sensitive electrode (which acts as the "null detector") by such things as contact potential differences, including those which occur among the internal probe parts as well as between the probe and external surfaces. These error signals produce an offset voltage at the probe (and output) of the instrument. A front panel zero control is provided which allows one to set a potential on the sensitive electrode which directly opposes these "error signals" and this permits zeroing the instrument.

Unfortunately, since not all of the elements contributing to the zero offset are independent of probe-to-surface separation, this zeroing technique is not completely independent of probe-to-surface separation either. If the instrument is set for zero volts out when "looking" at a grounded metal plate, small offsets will occur when the probe-to-surface spacing is varied. This effect is usually neglectable if the measured voltages are in the order of several hundred volts or if the probe-to-surface spacing can be held reasonably constant (within 1/8").

On the more sensitive ranges of the Model 144 however, a small variation can be very significant, and might possibly render the instrument unusable were it not for the following seroing technique which totally eliminates offsets resulting from changes in probe-to-surface spacing.

C. Special Zeroing Technique:

1. A method for continually varying the probe-to-surface spacing from approximately 0.010" to 0.250" while the probe "looks" at a grounded plate is required. This can be done by hand, but is preferable to use a mechanical device.

2. Observe the offset that occurs as the probe is lifted away from the grounded surface, and then incrementally adjust the zero control in the direction opposite to the offset (either "plus" or "minus") until there is no change in reading regardless of probe-to-surface spacing.

3. The resulting non-zero reading on the meter and output (typically 1 V) must be subtracted from any test data that is gathered. This is most easily accomplished by simply applying a compensating zero offset to whatever recorder is used with the Model 144. Another subtraction technique is to use a "bucking" voltage source in series with the Model 144 output, or applied to the (conductive) material whose surface potential is being monitored.

The success of this special zeroing technique results from the nulling of the contact potential differences among the internal probe parts while excluding external, distance dependent influences.

NOTE: It is always better to operate at as close as possible probe-to-surface spacings since random electrical noise will increase with increasing separation.

MONROE ELECTRONICS, INC.
Repair Price Schedule
Major Instruments

Effective: March 15, 1969

It is the policy of Monroe Electronics, Inc. to provide for the repair of all its standard products. Major instruments may be returned for repair regardless of age or condition.

The following price schedule, based on instrument age, is designed to simplify cost estimating for repair jobs. It reflects the cost of maintaining the technical skills required to repair obsolete instruments no longer manufactured or sold as well as the ever increasing costs of parts and labor.

Major instruments include the entire Electrostatic Products group, all power supplies and calibration equipment, and in general, any other instrument with a purchase price in excess of $500.00.

A. Labor--including small parts replacement:

Instrument Age	Price
Less than 1 year old	free (original warranty)
1 to 3 years old	10% of purchase price
3 to 5 years old	20% of purchase price
5 to 10 years old	50% of purchase price
Greater than 10 years old	75% of purchase price

B. Parts:

1. No extra charge for small part or component replacement.

2. Missing parts (or complete modules) will be charged at established selling price.

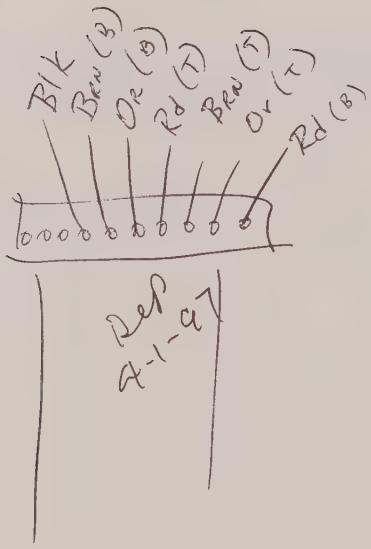
3. Parts or components damaged through physical or electrical abuse or misuse will be charged at established selling price.

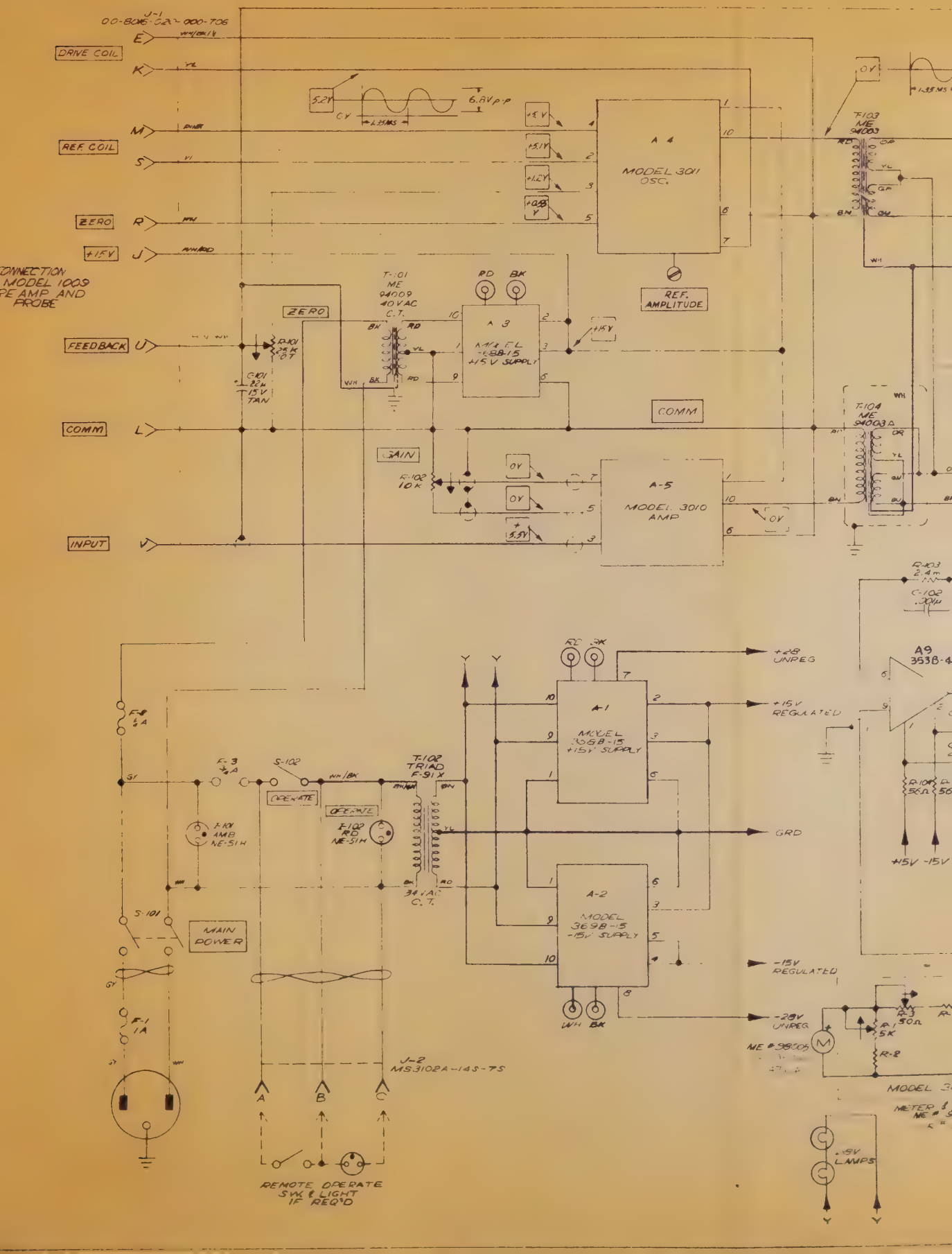
C. Warranty:

All instruments repaired on a "non-warranty" basis will also be completely tested and recalibrated and returned with a new instrument warranty--one full year from date of repair. Instrument age, however, will always be determined from date of original purchase.

12/68

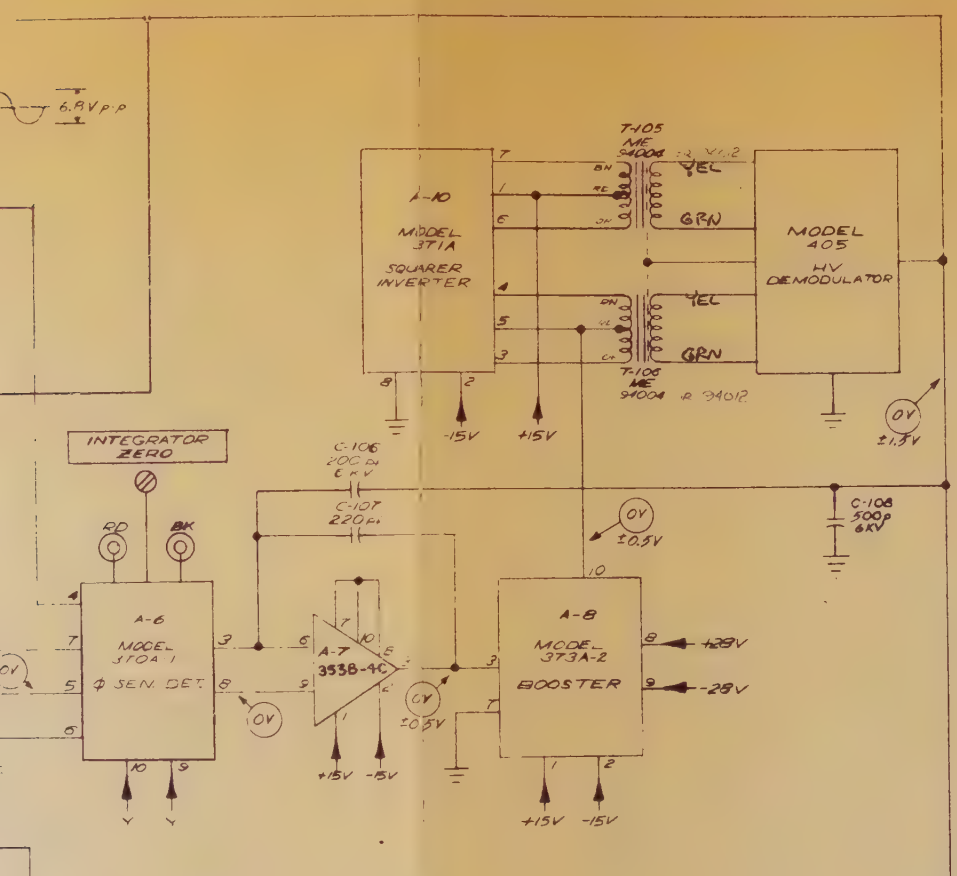
T.D —



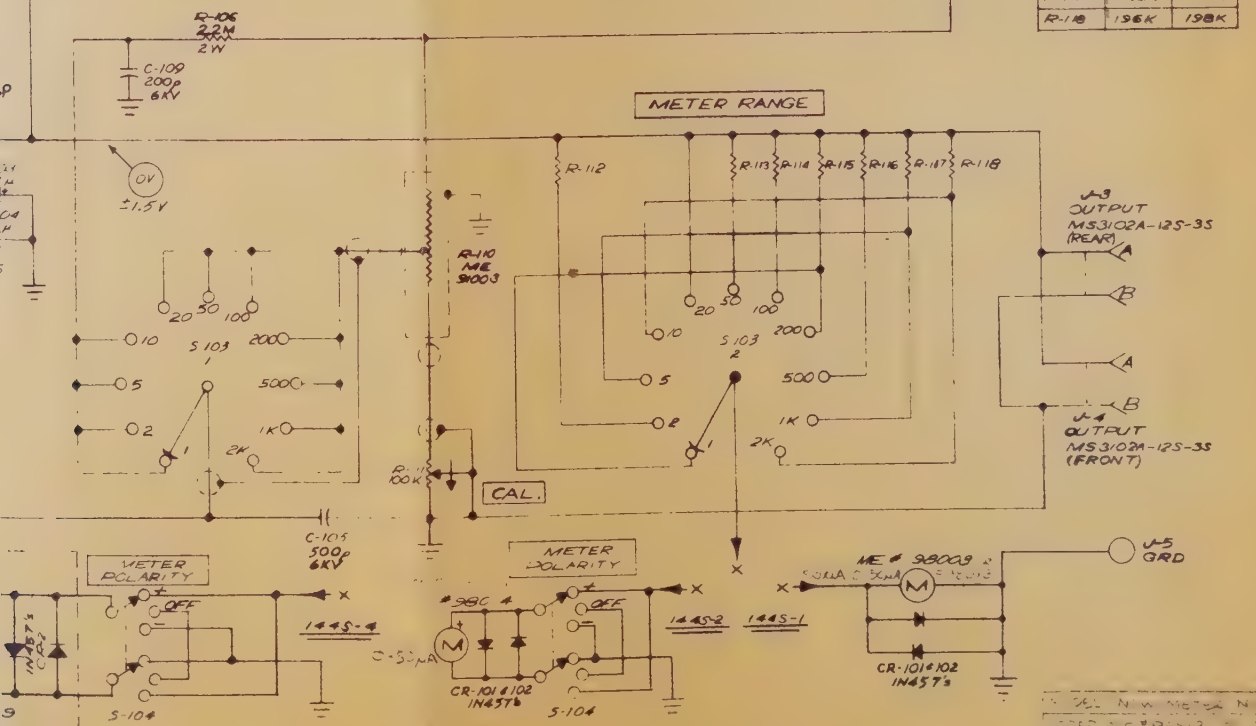

J-1
00-8046-022-000-T06
DRIVE COIL
E
K
REF. COIL
M
S
ZERO
R
+15V
J
CONNECTION
MODEL 1009
PE AMP AND
PROBE
FEEDBACK
U
COMM
L
INPUT
V
5.2V
CT
6.8V P-P
+8V
+5.1V
+4.2V
+0.8V
A 4
MODEL 3011
OSC.
REF.
AMPLITUDE
T-103
ME
94003
T-101
ME
94009
40VAC
C.T.
ZERO
A 3
MODEL
-6883-15
+15V SUPPLY
+15V
R-101
25K
C.T.
C-101
.22M
15V
TAN
COMM
T-104
ME
94003A
GAIN
R-102
10K
A-5
MODEL 3010
AMP
R-103
2.4M
C-102
.30M
A9
3538-4
F-2
5A
F-3
4A
S-102
OPERATE
T-102
TRIAD
F-91X
I-101
AMB
NE-51H
I-102
RD
NE-51H
34 V A.C.
C.T.
S-101
MAIN
POWER
F-1
1A
A-1
MODEL
3658-15
+15V SUPPLY
A-2
MODEL
3698-15
-15V SUPPLY
+28V
UNREG
+15V
REGULATED
GRD
-15V
REGULATED
-28V
UNREG
R-104
56Ω
+15V -15V
R-1
50Ω
R-2
5K
NE #98005
J-2
MS3102A-14S-7S
A
B
C
REMOTE OPERATE
SW & LIGHT
IF REQ'D
.8V
LAMPS
MODEL 3
METER
NE #

NOTE:
VOLTAGE MEASUREMENTS
OUTPUT MUST BE ZERO
ALL DC EXCEPT AS NOTED
±20% AS MEASURED WITH
20KΩ/V METER

○ REFERRED TO CHASSIS GRD.
□ REFERRED TO "COMM"



REF NO.	144-182 W, 1%	144-4 ½W, 0.1%
R-112	38.3K	38K
R-113	3.01K	3K
R-114	8.06K	8K
R-115	18.2K	18K
R-116	47.5K	48K
R-117	97.6K	98K
R-118	196K	198K



C-108 WAS 100p RLD 4-1-68

All instrumentation, circuitry designs and application data shown herein and related knowhow are CONFIDENTIAL and the property of Monroe Electronics, Inc. No use or disclosure thereof may be made without our written permission.

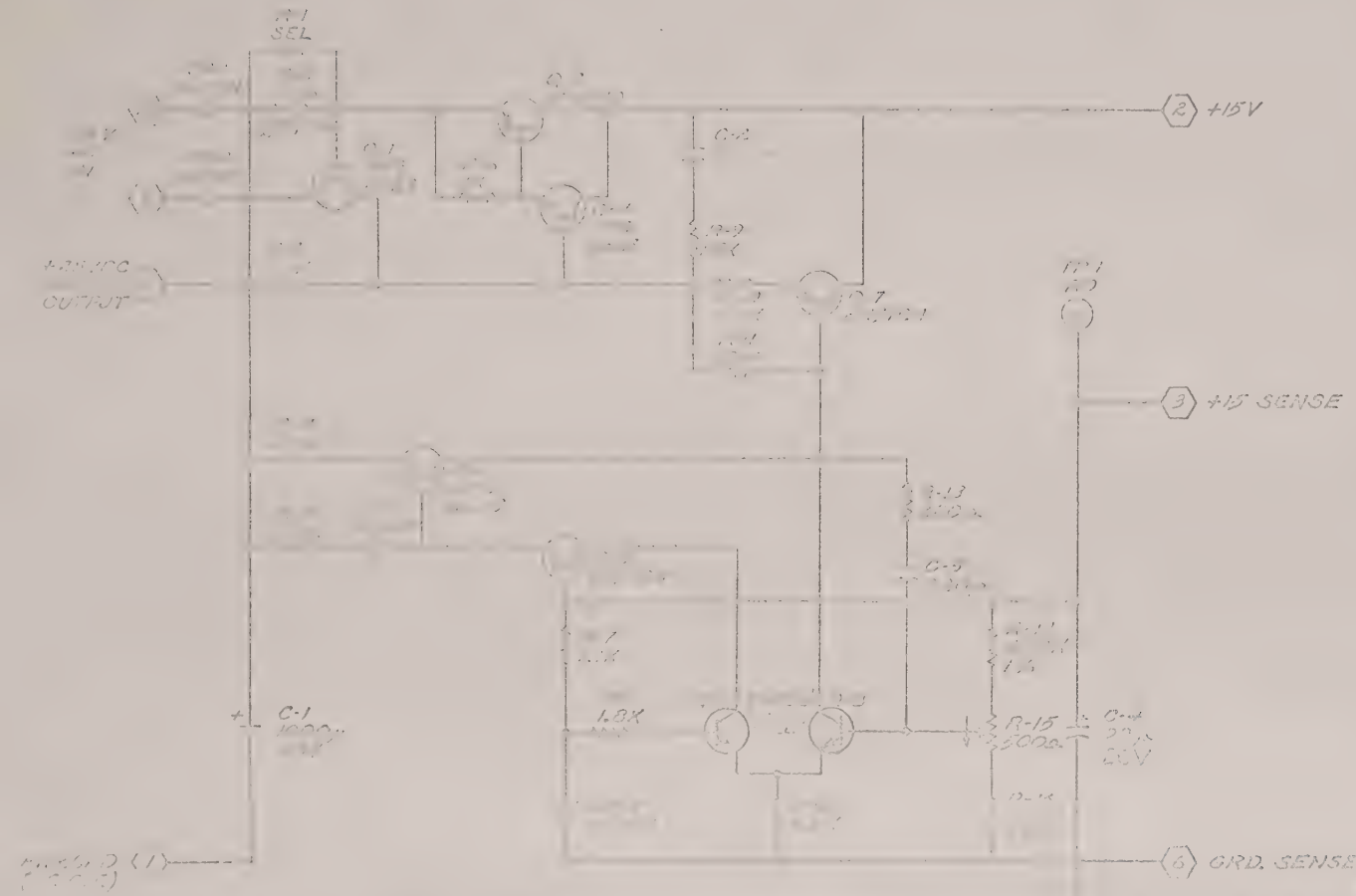
MONROE ELECTRONICS, Inc.
MIDDLEPORT, N. Y.
DRAWN GET 10-1-67

MODEL 144S
ISOPROBE®
ELECTROSTATIC VOLTMETER

144S/1

R-15
3.6K

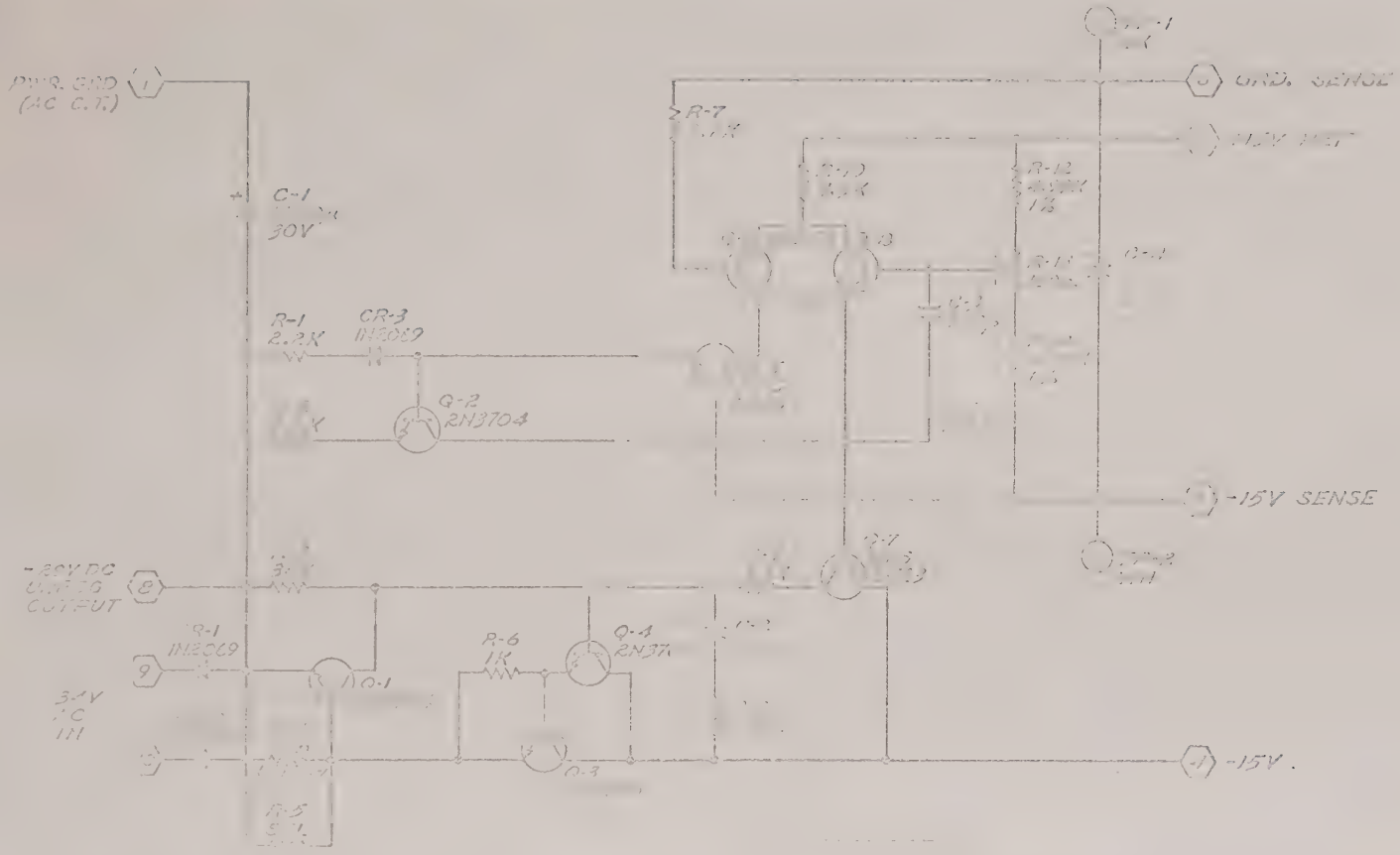
application data shown herein and related know-how are CONFIDENTIAL and the property of Teledyne Electronics, Inc. No use or disclosure thereof may be made without our written permission.



DRAWN	ADD			
CHKD				

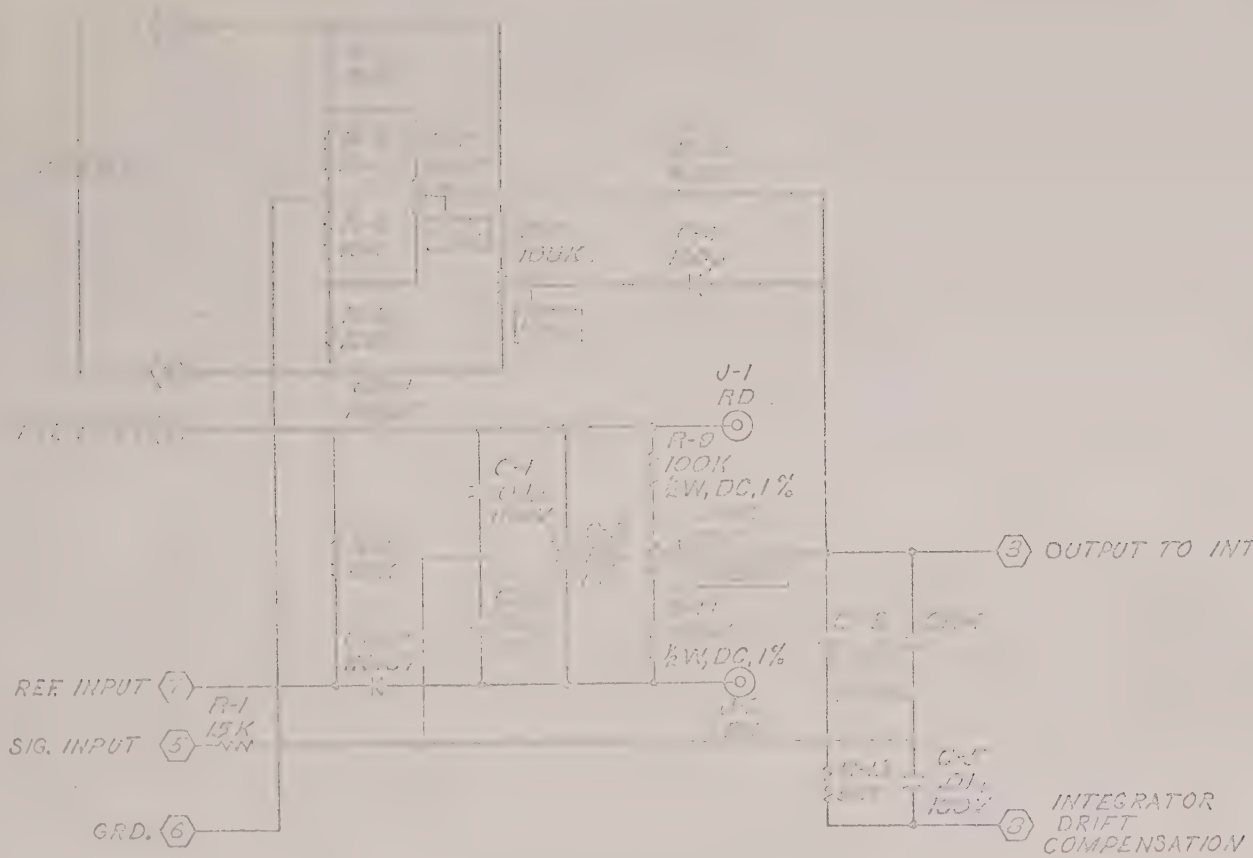
MODEL 3683-15
SUPPLY

All instrumentation, circuitry designs and application data shown herein are and remain know-how and CONFIDENTIAL and the property of Hewlett Packard, Inc. No use or disclosure thereof may be made without our written permission.



ALL RES. ¼W, 5% EXCEPT AS NOTED

All information, circuitry, design and engineering shown herein and related knowledge are CONFIDENTIAL and the property of Electronic Associates, Inc. Neither this nor any copy thereof may be used without our written permission.



R-1 W/S 10 K

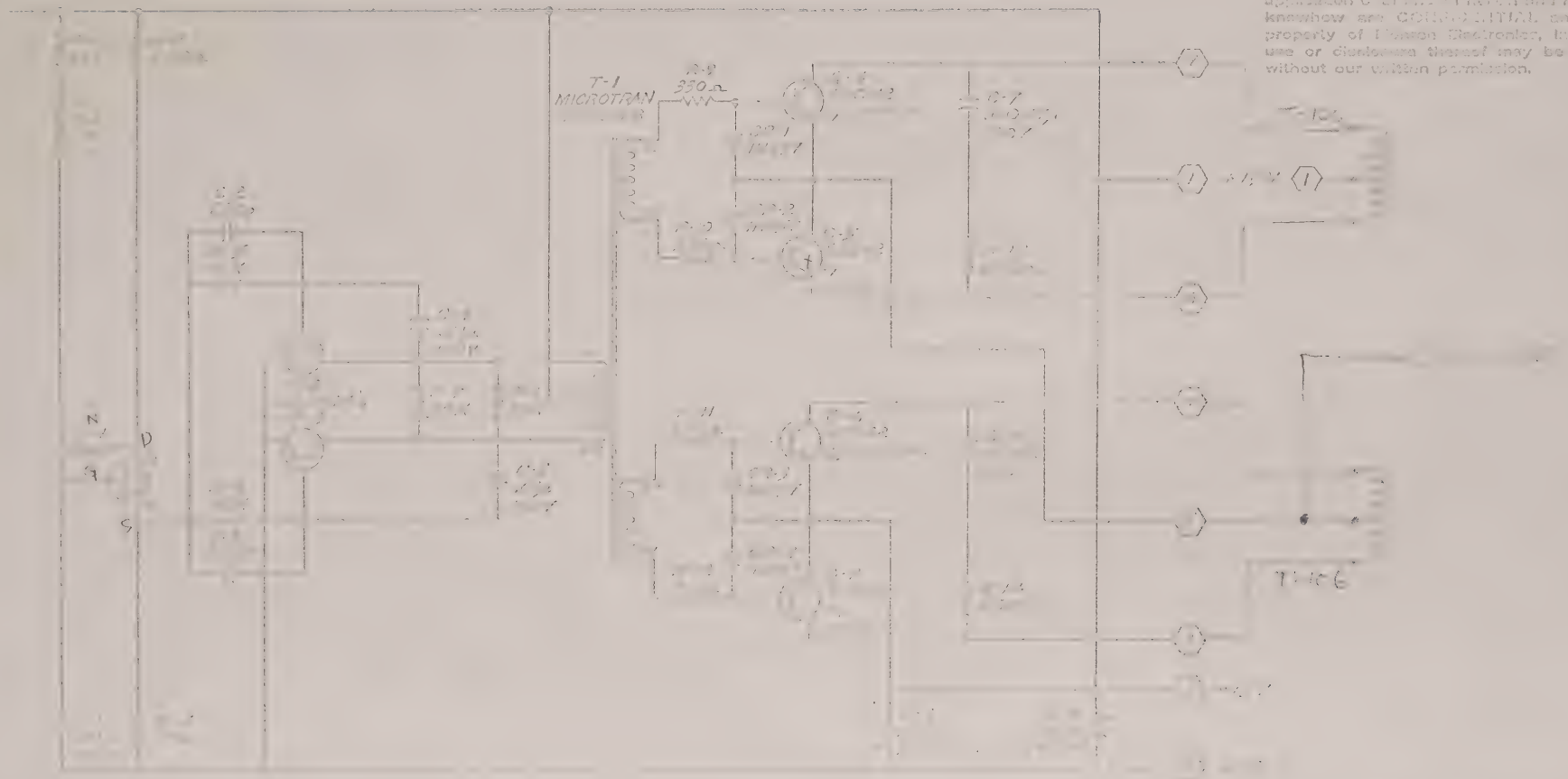
ALL RESISTORS ½W, 5% UNLESS OTHERWISE NOTED

DRAWN R.L.D

MODEL 370A-1
Ø SEN. DET.

370A/1

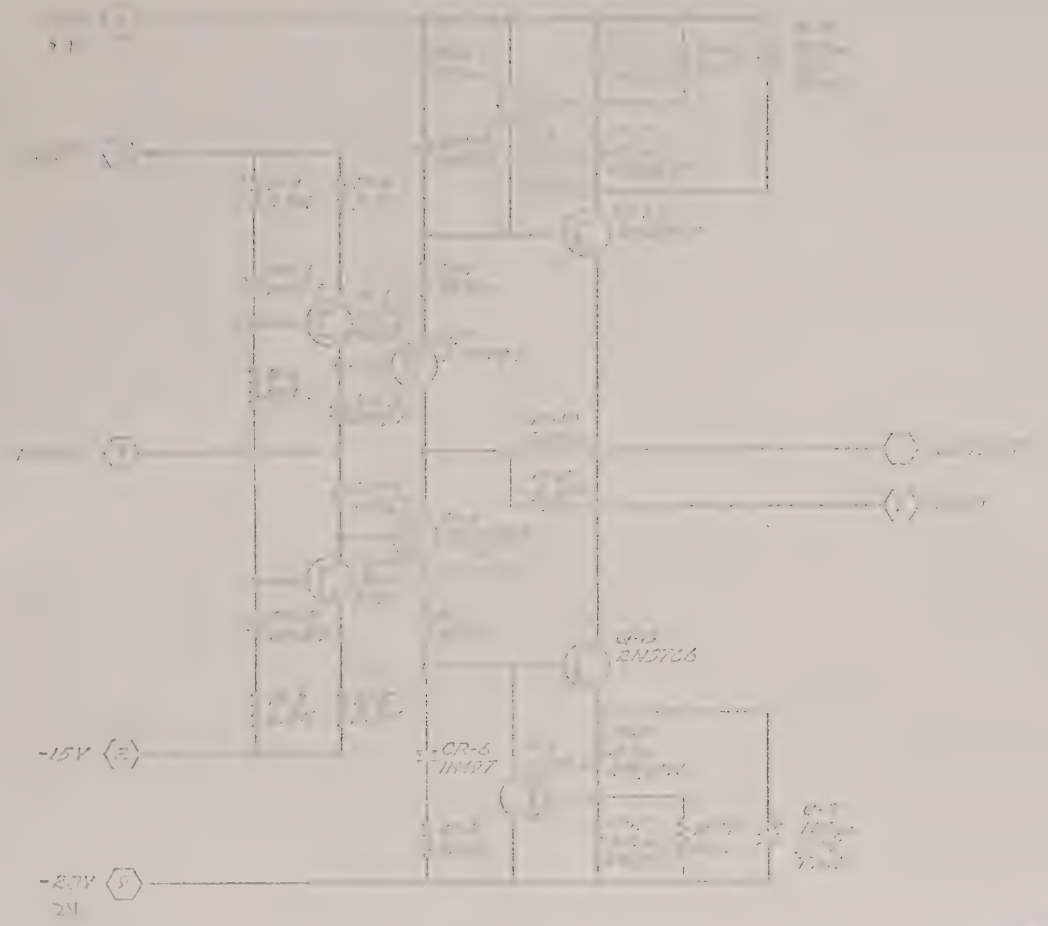
All instrumentation, circuitry, designs and application data shown herein and related know-how are CONFIDENTIAL and the property of Tyrrell Electronics, Inc. No use or disclosure thereof may be made without our written permission.



ALL RESISTORS ¼W, 5% EXCEPT AS NOTED

USE VOM TO CK DCL ON PINS - DCR-1

USE SCOPE TO CK FOR SQ WAVE (OUTPUT) GND TO 3,4,6+7

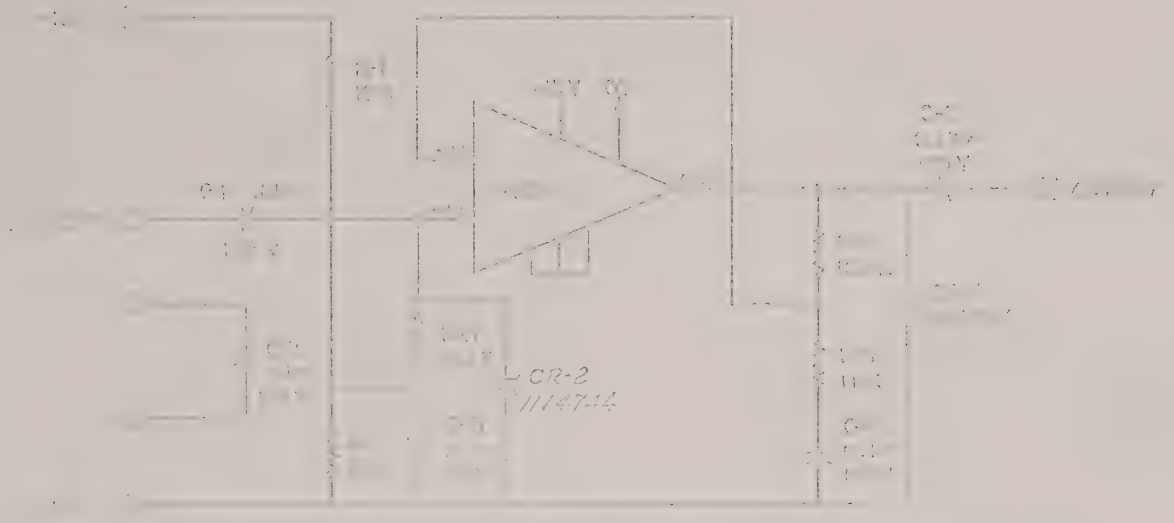


NOTE:
MODEL 373A-1, OMIT C-2 & 3

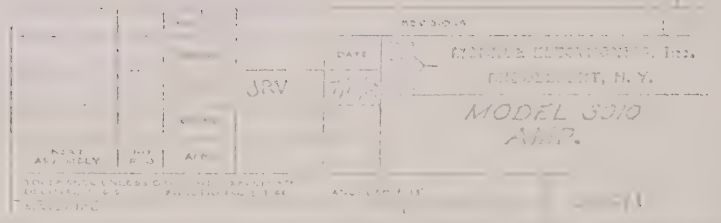
ALL RESISTORS ¼W, 5% UNLESS NOTED.

MODEL 373A-2
BOOSTER

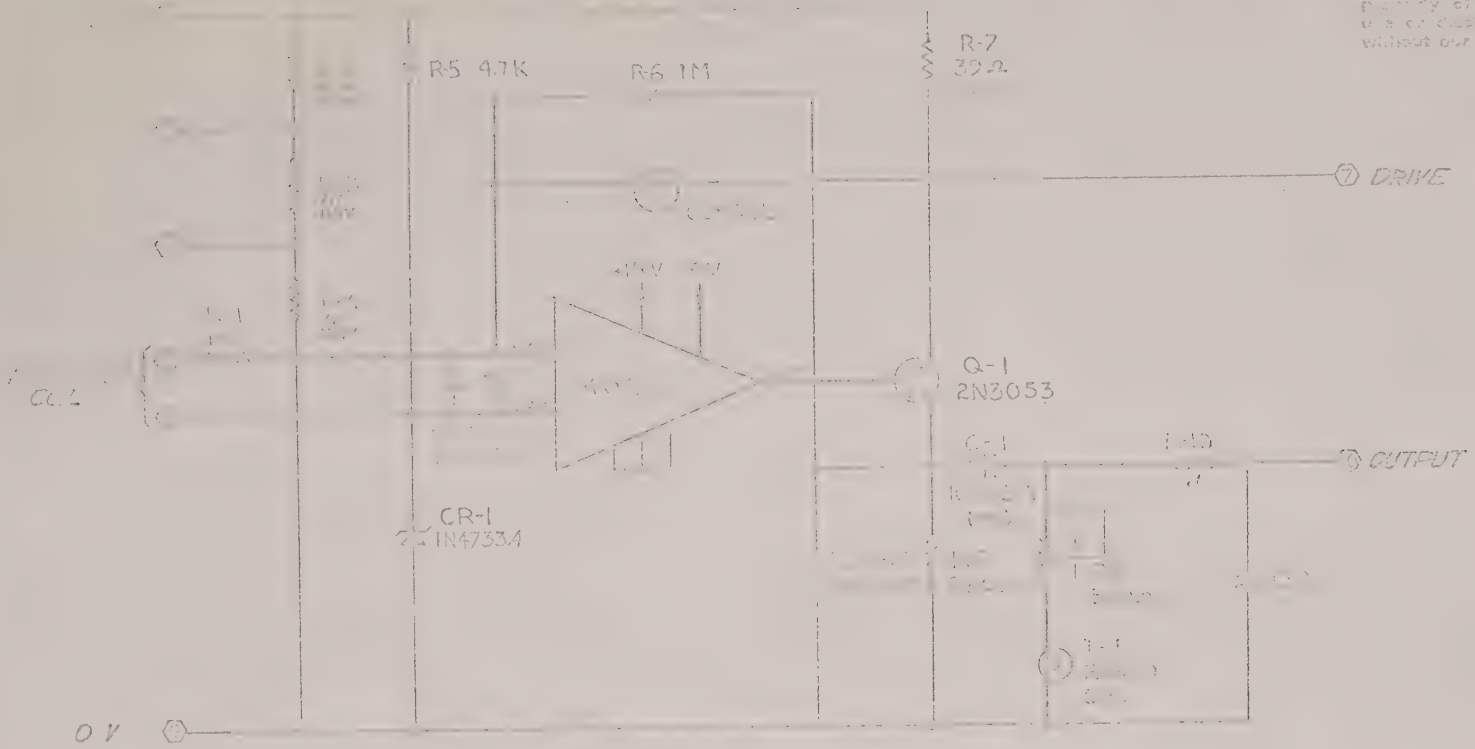
373A/1



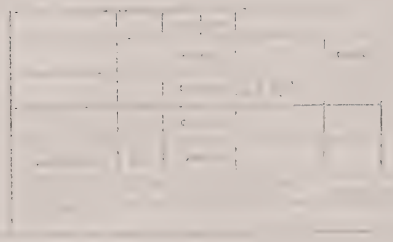
ALL RESISTORS ¼ ω 5% EXCEPT AS NOTED



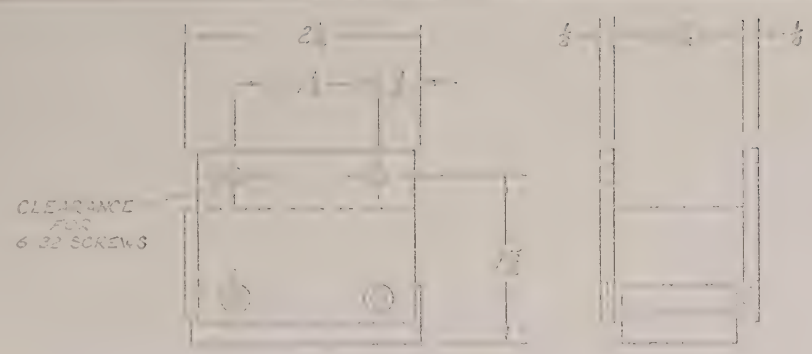
All information, circuitry, devices and applications contained herein are the property of [illegible] and may not be used or disclosed without our written permission.

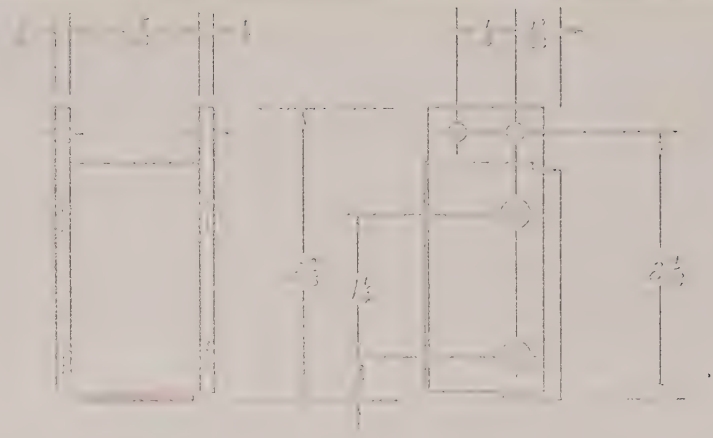


ALL RESISTORS ¼ω 5% EXCEPT AS NOTED



MODEL





HE 1009 UNIT
WITH 2-8-32 x 3/4" FLAT HEAD SCREWS, WHICH ARE
A PART OF THE 1009 ASSEMBLY. IT IS
RECOMMENDED THAT ONLY 2 SCREWS BE REMOVED
AT ONE TIME.

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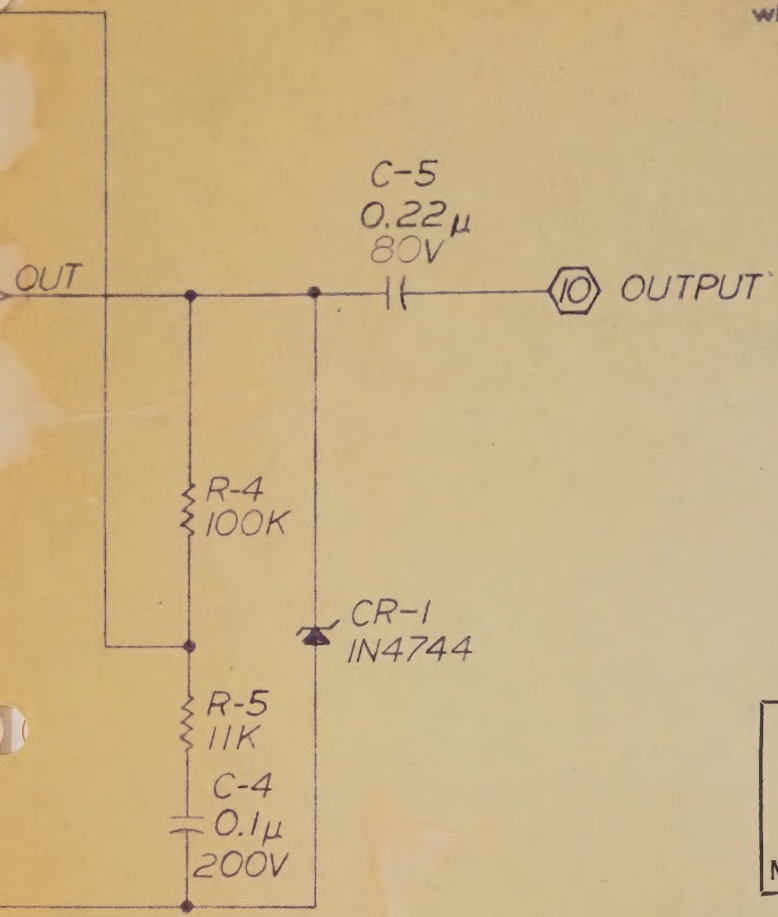


PRINTED
DEC 3 1973
MONROE ELECTRONICS, INC.

PT AS NOTED.
GE.

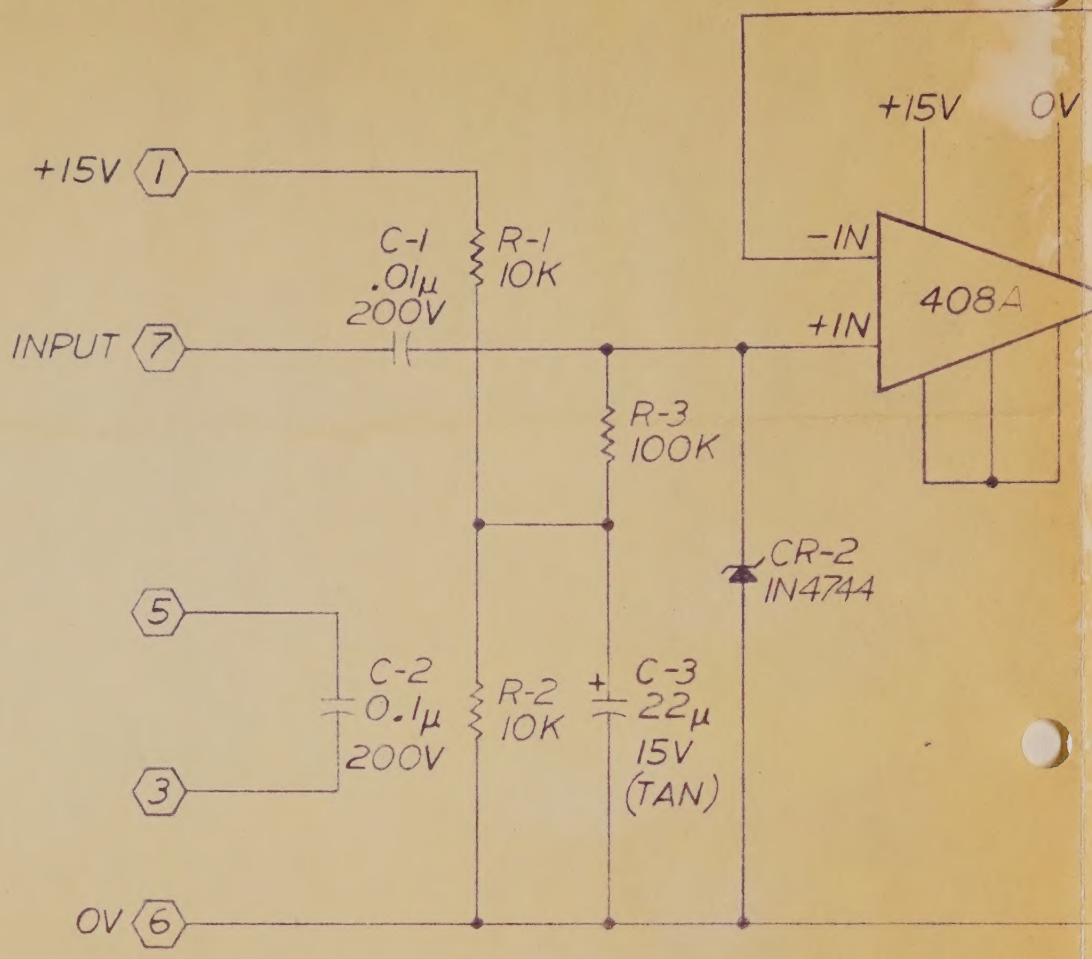
CHANGE

C1, C2 & C4 WERE 100V	MN	8-7-73	
ADDED NOTE 3.	MN	6-23-73	
C-4 FOR -1 WAS 35V	MN	2-1-73	
C-5 WAS 200V	BWC	2-1-72	
C-5 WAS 100V	BWC	2-16-71	3010/1
ADDED CR-2 IN4744	BWC	9-9-69	
ADDED CR-1 IN4744	VTT	8-27-68	

		LOC.	LET.	REVISIONS	DATE
		SCALE	NONE	DATE	MONROE ELECTRONICS, Inc. MIDDLEPORT, N. Y.
		DRAWN	BWC	9/9/69	
		CH'KD.			MODEL 3010 AMP.
NEXT ASSEMBLY	NO. REQ.	APP'D			

TOLERANCE UNLESS OTHERWISE SPECIFIED:
DECIMAL ± .005 FRACTIONAL ± 1/64 ANGULAR ± 15'
MATERIAL

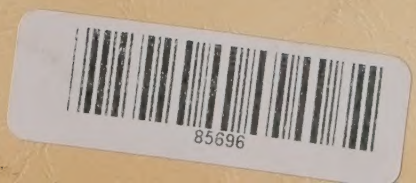
3010/1



NOTE:

1. ALL RESISTORS $\frac{1}{4}$W, 5% EXCE
2. FOR 3010-1 GAIN OF 100. CHA
   a. R-5 TO 1.1K
   b. C-4 TO 1.0μ, 50V
3. FOR 3010-3 GAIN OF 1000
   a. R-5 TO 110Ω
   b. C-4 TO 10μ 20V

KEY PIN 2


85696